The Engineer.

Established 1856. Registered as a Newspaper.

OFFICE FOR ADVERTISEMENTS & PUBLICATION, 28, ESSEX ST., STRAND, LONDON, W.C. 2.

VOL. CLII.—No. 3962] LONDON: FRIDAY EVENING, DECEMBER 18, 1931 [PRICE ONE SHILLING BY INLAND POST 1s. 3d.

PUBLIC NOTICES.

HEATING.

The Commissioners of His Majesty's Works, &c., are prepared to receive TENDERS before 11 a.m. on :—

(1) Wednesday, 6th January, 1932, for ACCELERATED LOW-PRESSURE HOT WATER HEATING, &c., at
(A) "Valentine" Telephone Exchange, Ilford, Essex ;
(B) The County Court, Shoreditch, E.
(2) Wednesday, 20th January, 1932, for ACCELERATED LOW-PRESSURE HOT WATER HEATING, &c., at the Royal Air Force College, Cranwell, Lincs.

Drawings, specifications, copies of the conditions and forms of contract, bills of quantities and forms for Tender may be obtained from the CONTRACTS BRANCH, H.M. Office of Works, King Charles-street, London, S.W. 1, on payment of One Guinea in each case (3 Contracts). (Cheques payable to the Commissioners, H.M. Office of Works.) The sums so paid will be returned to those persons who send in Tenders in conformity with the conditions. 7909

Bombay, Baroda and Central INDIA RAILWAY COMPANY.

The Directors are prepared to receive up to Noon on Friday, 1st January, TENDERS for the SUPPLY of : STEEL MATERIAL (Mild Steel Plates, Squares, Tees, &c.).

Tenders must be made on forms, copies of which, with specification, can be obtained at these offices on payment of 10s. each (which will not be returned).

The Directors do not bind themselves to accept the lowest or any Tender.

S. G. S. YOUNG, Secretary.

Offices : The White Mansion, 91, Petty France, Westminster, S.W. 1. 14th December, 1931. 7910

City and County of Kingston-upon-Hull.
CITY ENGINEER'S DEPARTMENT.
TO BATH WATER PURIFICATION PLANT ENGINEERS.
UNEMPLOYMENT RELIEF WORKS.

The Corporation is prepared to receive TENDERS for the SUPPLY and INSTALLATION of the BATH WATER PURIFICATION PLANT at West Hull Baths, Albert-avenue.

Forms of Tender and other particulars may be obtained at the City Engineer's Office, on payment of Three Guineas, which will be returned on the receipt of a bona fide Tender, together with the drawings supplied with the forms of Tender.

Tenders must be enclosed in the endorsed addressed envelope provided, and delivered at the City Engineer's Office, Guildhall, Hull, before Noon on Wednesday, the 13th January, 1932.

The acceptance of an offer will be subject to the observation by the Contractor of the Corporation's Fair Wages and Local Labour Clause.

The Corporation does not bind itself to accept the lowest or any Tender.

By Order, H. HAMER, City Engineer.

Guildhall, Hull, 16th December, 1931. 7919

Corporation of Durban (Natal).

The Corporation of Durban (Natal) is prepared to receive TENDERS for the SUPPLY and DELIVERY, free on board, of the following :—

ONE PETERSEN ARCING GROUND SUPPRESSOR for 33,000-volt Overhead Transmission,

to be approved by the Consulting Engineers, Messrs. Merz and McLellan, 32, Victoria-street, Westminster, S.W. 1.

Specifications can be obtained from, and sealed and endorsed Tenders must be delivered to, the undersigned not later than Monday, 4th January, 1932.

The lowest or any Tender will not necessarily be accepted.

By Order, WEBSTER, STEEL & CO., 9, St. Helens-place, Bishopsgate, London, E.C. 3, 7905 Agents to the Durban Corporation.

Galloway Water Power Company.
TENDERS FOR CONTRACT NO. 4.
11,000-VOLT OVERHEAD LINE.

The Galloway Water Power Company invite TENDERS for the SUPPLY and ERECTION of an 11-kV THREE-PHASE OVERHEAD LINE, approximated 6¼ miles long, between Glenlee Power Station and High Bridge of Dee, in the Stewartry of Kirkcudbright.

Copies of the specification and form of Tender may be obtained from the offices of the Company on application to the undersigned on or after the 21st December, 1931, on payment of a deposit of Two Guineas for the first copy and One Guinea for each subsequent copy. Sums paid for any number of copies up to three will be refunded on receipt of a bona fide Tender.

Tenders, on the form supplied, endorsed "Tender for Contract No. 4," must be delivered to the offices of the Company not later than Twelve Noon on 15th January, 1932. The Company do not bind themselves to accept the lowest or any Tender.

(Signed) T. LAWRIE, Secretary.

Galloway Water Power Co., Queen's House, Kingsway London, W.C. 2. 7911

The "Eureka" Note Changer Limited (in Liquidation), 162, Walton-street, S.W. 3, Manufacturers of Change-giving Apparatus.—The LIQUIDATOR is prepared to receive TENDERS for the PURCHASE of the GOODWILL, PATENT MACHINERY, STOCK-IN-TRADE and BOOK DEBTS of the COMPANY.

Particulars and conditions of Tender may be had on application to Ernest T. Wilkins, F.C.A., 47, Mark-lane, E.C. 3.

Tenders should be addressed to the said ERNEST T. WILKINS, at the above address, and should be delivered not later than Twelve Noon on the 1st January, 1932.

The highest or any Tender will not necessarily be accepted. 7916

The Civil Engineers Appointments BOARD, 8, Princes-street, Westminster, S.W. 1, acting under annual licence from the London County Council, invites INQUIRIES from EMPLOYERS SEEKING the SERVICES of PROFESSIONAL ENGINEERS, either as Assistants or in more responsible positions.

All those whose names are accepted for entry in the Board's Register for employment possess qualifications which have been attested by means of scientific examinations, practical training and experience. P1577

The Engineer

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PUBLIC NOTICES.

The Engineers' Register of the JUNIOR INSTITUTION OF ENGINEERS, 39, VICTORIA-STREET, S.W. 1, licensed annually by the London County Council, contains the names and specialised experience of many Members, both Junior and Senior Men, who are available for service in administrative and technical capacities in all branches of engineering.

Employers seeking such men for service, either in Great Britain or abroad, are invited to address their inquiries to the SECRETARY. P1627

Rother and Jury's Gut Catchment BOARD.
APPOINTMENT OF ENGINEER.

APPLICATIONS are INVITED for the APPOINTMENT of an ENGINEER to the above Board, at a salary of £500 per annum, plus travelling allowance to be agreed.

Applicants should have experience in Foreshore Protection and Land Drainage Works.

Applications must be in writing, stating age, experience and qualifications, endorsed "Engineer, Catchment Board," and addressed by post to me, the undersigned, so as to reach me not later than Friday, 15th January, 1932.

Canvassing, directly or indirectly, will disqualify.

DONALD A. JONES, Clerk to the Board.

Watch Bell Chambers, Rye, Sussex, 16th December, 1931. 7918

PUBLIC NOTICES.

H.E.H. The Nizam's State RAILWAY.

REQUIRED, for service on the above Railway, ONE ASSISTANT LOCOMOTIVE SUPERINTENDENT.

Candidates should have the following qualifications : —Age about 24 to 26 years, preferably unmarried. They must have obtained a recognised Engineering Degree, or have passed the Associate Membership Examinations of the Institutions of Civil or Mechanical Engineers. They must have served at least three years' apprenticeship in the workshops of a railway, or with a well-known firm of locomotive builders, and have had running shed and footplate experience.

SALARY.—Within the grade of Osomania Sicca Rupees 400 to 800 per mensem, with annual increments of O.S. Rs. 25 per mensem. Commencing salary according to qualifications.

(NOTE.—Average exchange between O.S. Rupees (Hyderabad State currency) and British Government Rupees is approximately 116 O.S. to 100 B.G.)

TERMS.—A three years' agreement in the first instance, first-class free passage to India and a return passage (if a European is appointed) on satisfactory termination of service. The selected candidate will be required to pass a medical examination before appointment.

Applications (by letter only), giving full details of applicants' general and technical education, practical training and subsequent experience, should be addressed to the undersigned not later than 21st December, 1931.

F. ADAMS, Secretary, H.E.H. the Nizam's State Railway Board. Winchester House, 100, Old Broad-street, London, E.C. 2, 14th December, 1931. 7906

SPECIAL NOTICE.

Owing to Christmas Holidays all advertisements intended for the Classified Advertisement Section of December 25th issue must reach this office not later than first post on Wednesday, December 23rd.

28, Essex Street, Strand, W.C. 2.

PUBLIC NOTICES.

Borough of Ilford and Borough OF BARKING.
ILFORD AND BARKING JOINT SEWERAGE COMMITTEE.
PUMPING STATION AND STORM WATER TANKS.
CONTRACT No. 8.

The above Authorities are prepared to receive TENDERS for the CONSTRUCTION of JOINT PUMPING STATION, STORM WATER TANKS, STORM WATER OUTFALL and APPURTENANT WORKS at Barking.

Plans may be seen, and general conditions of contract, specification, quantities and form of Tender, may be obtained at the offices of the Engineers, Messrs. W. H. Radford and Son, Albion Chambers, Kingstreet, Nottingham, on deposit of Five Guineas (cheque), which will be returned on receipt of a bona fide Tender and the return of the quantities.

Plans may also be seen at the Town Hall, Barking, or the Town Hall, Ilford.

The lowest or any Tender will not necessarily be accepted.

Sealed Tenders to be delivered to the undersigned on or before the first post on Monday, January 18th, 1932, endorsed "Pumping Station Contract."

By Order of the Joint Committee of the above Authorities.

ADAM PARTINGTON, Clerk to the Committee.

Town Hall, Ilford, 18th December, 1931. 7927

SITUATIONS OPEN.

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

TO ADVERTISERS UNDER BOX NUMBERS IN THIS CLASSIFICATION.

For the benefit of applicants, the Proprietors are prepared to insert brief notices that vacancies are filled, upon receipt of notifications from the Advertisers. These notices (limited to one line) will be free of charge and co-operation is asked for.

BOX No. 7848, 28th November.—This VACANCY has been FILLED and unsuccessful applicants are thanked for submitting particulars. P1834 A

WANTED for Large Tool-room in South of England, MAN capable of TAKING COMPLETE CHARGE. Production includes Manufacture of Press Tools, Forging dies, Small Jigs, &c., and maintenance of same. Must be capable of organising Production on most economic lines.
Reply stating experience and age.
Address, 7917, The Engineer Office. 7917 A

ASSISTANT ENGINEER.—APPLICANTS for the POST advertised in this Journal for November 6th, are INFORMED that this VACANCY IS NOW FILLED.—HENRY HOPE and SONS, Ltd., Smethwick, Birmingham. 7921 A

ROAD CONSTRUCTION ENGINEER REQUIRED by prominent North of England Contractors. Must be fully conversant with all types of Road Construction, including estimating, contract work, and supervision. Only men with first-class experience and credentials will be considered.—Confidential applications to Box "P," Kidd's Advertising Agency, Middlesbrough. 7920 A

SALES ENGINEER, with Experience in Design of and carrying out Reinforced Concrete Structures and particularly Pile Foundations, with connection London area. Permanent post. Age about 35.
Address, giving full particulars of education, experience, and salary required, 7914, The Engineer Office. 7914 A

SITUATIONS WANTED.

ABROAD.—MECHANICAL ENGINEER (31), with previous experience abroad in charge construction, operation and maintenance locomotives, heavy haulage plant, B. and W. boilers, water pumping plant, Diesel and I.C. engines, conveying, crushing and drying machinery, repair workshops, DESIRES responsible POST abroad ; steam certificate, Malay.—Address, P1818, The Engineer Office. P1818 B

CONSTRUCTIONAL ENGINEER, 16 Years' Experience bridge construction and steel-framed buildings, REQUIRES WORK, home or abroad ; daywork or contract ; highest refs.—Address, P1832, The Engineer Office. P1832 B

ELEVEN Years' Locomotive, Carriage, Wagon and general mechanical experience. Qualified draughtsman. Small start with prospects.—Address, P1829, The Engineer Office. P1829 B

ENGINEER (36), A.R.S.M., Extensive Experience railway location, tunnelling, bridges, &c., large public works, London. Expert surveyor, French, Spanish.—Address, P1833, The Engineer Office. P1833 B

EXPERIENCED ENGINEER is DESIROUS of OBTAINING TRANSLATION of TECHNICAL and METALLURGICAL MATTER from the French Language, Reviews of Technical Publications, Descriptions of Plant, &c.—Address, P1802, The Engineer Office. P1802 B

FACTORY ENGINEER, A.M.I. Mech. E., Steam, oil, electric, mechanical, install. run, maintain ; extensions and overhauls.—Address, P1755, The Engineer Office. P1755 B

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MECHANICAL ENGINEER (28), B.Sc., Speaking Italian and French, 9 years research, production and shop management with well-known electrical concern, REQUIRES NEW POSITION OF RESPONSIBILITY, owing to closing down of department. Would undertake to collect first-class nucleus staff for new production.—Address, P1839, The Engineer Office. P1839 B

MECHANICAL ENGINEER (26) WISHES APPOINTMENT ABROAD; 4 years workshop, 2½ years drawing-office, 3 years maintenance in India. Tech. college trained. Steam and oil engines, waterworks, structural and general engineering. Excellent refs.—Address, P1836, The Engineer Office. P1836 B

MECHANICAL ENGINEER (31), 9 Years British rly. abroad, sound D.O. and test experience, economical works management and maintenance of steam and hydraulic plant, specialised in use of oil fuel, lately disengaged from works manager's position N. of England, fluent Spanish, DESIRES POSITION OF TRUST.—Address, P1798, The Engineer Office. P1798 B

DESIGNER, Light Machinery, Varied English and American experience, practical, CAN SUPPLY or TAKE SCHEMES THROUGH OFFICE and SHOP to FINISHED ARTICLE. Whole or part time, at employer's or own address. Speaks French.—Address, P1841, The Engineer Office. P1841 B

DRAUGHTSMAN, Mechanical, Shop and Technical training, used to special machines for manufacture and production.—Address, P1842, The Engineer Office. P1842 B

EDUCATIONAL

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PREPARATION
FOR THE
Examinations
OF THE
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INST. OF STRUCTURAL ENGRS.,
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ARE PERSONALLY CONDUCTED BY
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For full particulars and advice apply to :—
36, DALE STREET, LIVERPOOL.
LONDON OFFICE :—65, CHANCERY LANE, W.C. 2.

T.I.C.B.
CORRESPONDENCE COURSES
FOR THE
PROFESSIONAL EXAMINATIONS
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(Founded 1917. 18,000 Successes.)

AGENCIES.

AGENT WANTED, Experienced Selling Grinding Wheels, for new patent, improved, cheaper, wheel.—Address, P1831, The Engineer Office. P1831 D

ALFRED WISEMAN, Ltd., Glover-street, Birmingham, WISH to APPOINT AGENTS for the SALE of their HIGH-SPEED DIESEL ENGINES, which comprise Marine Sets, Stationary and Lighting Sets, together with Engines for Transport.
Please state in application whether the whole range can be handled satisfactorily, giving evidence in support thereof, together with the area which can be covered. P1843 D

MANUFACTURERS and ENGINEERS DESIROUS of EXTENDING their BUSINESS in London on a commission basis please communicate with "ADVERTISER," Hastings House, Norfolk-street, Strand, W.C. 2. P1840 D

EXPERIENCED ENGINEER, A.M.I.C.E., M.I.M.E., DESIRES AGENCY for good Mechanical or other Speciality.—AGENCY, 53, Victoria-street, Westminster, S.W. 1. P1844 D

EXPERIENCED SALESMAN, Having Good Connection with leading engineers and automobile manufacturers, SEEKS AGENCY (Sheffield steel or similar line) in Birmingham district.—Address, P1827, The Engineer Office. P1827 D

MISCELLANEOUS

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BRITISH INSTITUTE OF ENGINEERIN TECHNOLOGY,
22, Shakespeare House, 29/31, Oxford-street, LONDON. P1804 I

PAPIER MACHÉ
Friction Pulleys,
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On Admiralty and War Office Lists.
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For Coating Boilers, Steam Pipes, &c
Prevents the radiation of heat, saves fuel, and increases the power of Steam.
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FOR CHILDREN
BROADSTAIRS.
For the Early & Preventive Treatment of Disease & Convalescence after illness.
Managed by a Committee appointed by the Council of the Institution of Civil Engineers.

The Hospital is intended for the children of members of the Institution of Civil Engineers, the children of architects, artists, authors clergymen, members of the medical, legal and other professions, members of scientific societies, officers of the Navy, Army, and Royal Air Force, officers of the Merchant Navy, schoolmasters and university professors.

Accommodation is provided for 50 Boys between the ages of 4 and 12 years, and 50 Girls between the ages of 4 and 14 years. In special cases the age limits may be raised to 14 for Boys and 16 for Girls.

Fee **21/-** per week, or as may be arranged, and travelling expenses.

Particulars can be obtained from the Secretary:—
116, Victoria Street, Westminster, LONDON, S.W. 1.

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CAPACITIES UP TO 125 TONS
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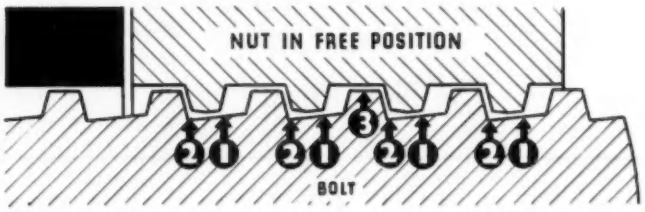

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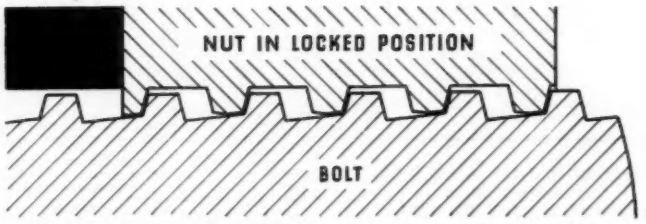

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ALSO B.S.W. AND B.S.F. BOLTS, NUTS, STUDS, SET SCREWS AND ATKINS SOCKET SCREWS
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CRANES
Derrick & Overhead Travelling Cranes
Worked by Hand, Power, and Electric.
JOHN SMITH (Keighley), LTD.
See last week's advertisement, page 7.

FOR SALE.

FOR SALE.—A 6-wheel, 12in. Manning LOCO.; last working 160 lbs. pressure. Price £150. Also a SUPERHEATED Sentinel STEAM LOCO.; very modern; 275 lbs. pressure. Price £125.—Address, 7925, The Engineer Office. 7925 G

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DRAWING INSTRUMENTS, SECOND-HAND
CLARKSON'S, 338, High Holborn, W.C.
(Opposite Gray's Inn-road).
FOR SALE, LEVELS.
DRAWING INSTRUMENTS, SECOND-HAND.
CLARKSON'S, 338, High Holborn, W.C.
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THE UNITED STEEL COMPANIES LTD
STRIP FOR DEEP STAMPING & PRESS WORK
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Telegrams: "Evaporator," Johnstone.
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See illustrated advt.

WELDLESS STEEL TUBES.
Large stocks of 8", 8¼", 8½" and 10½" all outside diameters. ⅛", ¼", ⅜" and ½" thickness.
Long random lengths, plain ends.
Also smaller sizes down to 2".
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For Home & Colonial Use.
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A Seven-Day Journal

The New Spey Bridge.

ON Friday of last week, December 11th, the new bridge over the river Spey at Spey-avenue, Grantown, was formally opened, in the presence of over 2000 people, by the Mackintosh of Mackintosh, the Lord Lieutenant of Inverness-shire. It replaces the old bridge, half a mile downstream, which in 1754 was built by Lord Charles Hay. The new bridge is a single span of 240ft., constructed in reinforced concrete. The height of the arch is 24ft. It was designed, and its construction supervised, by Messrs. Blyth and Blyth, of Edinburgh, the contractors being Messrs. Melville, Dundas and Whitson, of Glasgow. The bridge was begun in April, 1930, and very satisfactory official tests were made in November last. The arch is supported on piers on either side of the river, which have been carried down to a level of 23ft. below the river bank. There are four ribs, each about 6ft. deep and 4ft. wide, with reinforced concrete columns and decking, upon which the roadway rests. It has a width of 18ft. between the curbs, and there are 4ft. 8in. footpaths on either side. In each of the ribs three steel hinges have been built for the purpose of neutralising stresses arising either from changes in temperature or any possible settlement in the foundations. The wing walls of the bridge are carried back from the edge of the river about 30ft., and there is a small arched opening on each bank for the convenience of pedestrians and fishers. In order to make the colour of the new bridge blend pleasantly into the surrounding landscape, extensive experiments with coloured cements were carried out. It was finally decided to face all the exposed surfaces with a mixture of coloured cement and a special stone aggregate. In the main elevation features a local yellow-coloured freestone was employed, while in some other parts a paler colour was obtained by utilising local granite crushings as the aggregate. All the surfaces were then brush-hammered, which has exposed small particles of the stone, thereby giving a surface finish which, with the bold lines of the elevation, has produced a very pleasing effect, and has been the subject of favourable comment.

Employment in British Shipping.

AT the annual general meeting of the Orient Steam Navigation Company, Ltd., which took place in London on Tuesday last, December 15th, Sir Alan G. Anderson, who presided, gave in the course of his speech some interesting particulars as to the amount of British employment brought into being by the ships of the Orient Line fleet. The staff at sea and ashore in this country and Australia numbered, Sir Alan said, about 3000 persons. The amount of the annual depreciation which replaced capital spent on the fleet might be regarded as having paid the wages for one year of about 1000 British workers. On the catering side about 84 per cent. of the bill was spent in Australia and Great Britain and should employ about 700 workers. If such items as the sums spent both in foreign ports and Suez Canal dues were excluded, the general expenses which went to both British and Australian wage-earners should provide a living for more than 2000 persons. On the basis of this calculation, the seven ships of the Orient Line directly or indirectly found the wages of nearly 7000 workers of the British Empire, without mentioning their dependents and the shops to which their custom went. Instancing the value of a regular and contented staff, Sir Alan remarked that although the men only sign on for the voyage, he recently found by taking a census of the stewards' department that 97 per cent. of them rejoined the ship, while a quarter-deck man who had just retired had served the company for over fifty years.

The New Cunard Liner.

ON the afternoon of Thursday, December 10th, the decision of the Cunard Steam Ship Company, Ltd., to suspend work on the new liner "No. 534," under construction at Clydebank, became known and was received with something like consternation alike in both shipping and industrial circles. The question of Government intervention with a view to proceeding with the building of the ship, and so avoiding a stoppage, was raised in the House of Commons by Mr. Kirkwood on Friday. In his reply Mr. Runciman, the President of the Board of Trade, revealed the fact that the probable suspension of work had been confidentially known to the Government for several days, and had been the subject of careful thought. He pointed out that the considerations put forward so fairly by the Cunard Company in its circular to the shareholders issued on Thursday of last week, which described the altered position of the financing of the building of the ship brought about by the national and international crisis, appeared to be insurmountable. The Government had kept in close touch with the owners and builders of the ship since the question of suspension of work was first involved, but much as the Government regretted the stoppage, direct financial aid could not be given and had not been sought. If the Cunard Company had any proposals to make they would be most seriously considered. On Friday morning notices were posted in the Clydebank Yard of John Brown and Co., Ltd., intimating that all work on Contract No. 534 in the shipyard, engine and boiler works would cease as from noon on Saturday, December 12th. Since that time Mr. D. Kirkwood has made unremitting efforts to bring about a resumption of work and has remained in closest touch with Sir Thomas Bell and the Provost of Clydebank. It was announced on Tuesday that a conference between the Board of Trade and the Federation of Engineering and Shipbuilding Trades is to be held on Tuesday next, and that suggestions will then be put forward by the trade unions. On Wednesday last the Cunard Steam Ship Company, Ltd., deferred consideration of the ordinary agenda at its monthly board meeting, in order to discuss the situation. Sir Percy Bates, the chairman, reviewed the position and stated that, whilst other parties had been in touch with the Cabinet, he himself had received no request to meet it. The directors had received numerous letters from all classes of people urging a public appeal, and amongst other suggestions, proposing the issue of further new capital. In some cases correspondents had gone so far as to include contributions! The directors, said Sir Percy, were much gratified by this indication of the esteem and respect felt for the company. These suggestions were considered at some length by the Board, and the conclusion finally reached was that the technical difficulties of dealing with a further capital issue in small sums were very great, and it was exceedingly difficult to form a definite opinion in the matter of a public subscription, but it was felt that its very novelty, instead of militating against it, might lead to its success.

The Science Museum.

IT is with pleasure that we record the recent gift and loan of important groups of scientific instruments and models to the Science Museum at South Kensington. They may be divided into two main groups, given by Mr. Thomas H. Court and the British Electrical and Allied Manufacturers' Association. Mr. Court's gift comprises about 600 instruments relating to optics, astronomy, mathematics, and surveying, which have been chosen with the definite object of filling up gaps which existed in the collections representing the development of instruments from the sixteenth to the middle of the nineteenth century. The BEAMA gift and loan includes a collection of electrical measuring instruments and apparatus brought together and arranged for the recent Faraday Centenary Exhibition at the Albert Hall by Mr. R. W. Paul, more than three-quarters of which have been either presented or lent by the owners. The working model of a complete electrical generating, transforming and switching installation made by the BEAMA, and illustrated in THE ENGINEER of September 25th, is also included in the new exhibits at South Kensington A recent innovation at the Science Museum is the children's gallery, which has been specially designed by Sir Henry Lyons and is situated in the basement near to the main entrance. The story of transport and lighting throughout the ages is effectively portrayed by a series of illuminated scenes on miniature stages, while there are larger working models which can be operated by the visitors. The crafts of the flint worker, the pottery maker, and the smith are illustrated by life-sized models, and several times each day films depicting these crafts are exhibited. The new gallery is open for the same hours as the other parts of the Museum.

Long Distance Wireless Communication.

SEATED in a room at Savoy-hill on Saturday, December 12th, Marchese Marconi sent out the letter "S" as he first heard it across the Atlantic thirty years ago. The occasion was a wireless "Roll call" of sixteen nations in commemoration of the thirtieth anniversary of Marconi's successful reception of the first wireless signal across the Atlantic on December 12th, 1901. The story of his triumph told by himself, and a speech by Sir John Reith, together with messages from representatives of other nations, were broadcast throughout America. Speaking of his experience, Marchese Marconi said his thoughts went back to the moment when, standing in a bitterly cold room on the top of a hill in Newfoundland, he wondered if he would be able to hear the simple letter "S" transmitted from England. From the time of his earliest experiments he had always been convinced that radio signals would be transmitted over the greatest distances on the earth. His first problem, however, was to prove that an electric wave could be sent across the Atlantic and be detected on the other side. On November 26th, 1901, he sailed from Liverpool, accompanied by two technical assistants, with the object of endeavouring to detect in Newfoundland radio signals transmitted from a special station erected at Poldhu in England. The party reached St. John's, Newfoundland, on December 6th and erected a receiving station on Signal Hill. On December 12th they flew a kite carrying an aerial some 400ft. long, and at about 12.30 p.m. a succession of three faint clicks corresponding to the pre-arranged signal were distinctly heard in the telephone receiver. Thus electric waves sent out from Poldhu in Cornwall had traversed 1700 miles of the Atlantic unimpeded by the curvature of the earth, exactly as he had always believed would be the case.

A Faraday Exhibition at Exeter.

FROM Thursday, December 10th, until Saturday, 12th, the Exeter Faraday Centenary Committee held an exhibition of Faraday's relics and modern electrical appliances in the new science block of the University College of the South-West on the Streatham estate. The Centenary Committee, with Professor F. H. Newman as secretary, received the co-operation of the City Council and traders, and among the visitors were Sir William Bragg—who lectured on Michael Faraday—Sir Ambrose Fleming, and Mr. W. B. Faraday, a great-nephew of the scientist. Presiding at the official opening, Professor Newman explained that he had prevailed on Principal Murray to open the exhibition, and it was very appropriate that he should do so, as it was the first public function to be held in the new Washington Singer laboratories. Thanks were due to the various firms which had contributed to the exhibition and to the City Corporation for a generous supply of electricity. Sir William Bragg congratulated the Committee on the fine exhibition, and explained that Faraday had one of the first laboratories in this country, and one in which he (Sir William) still worked every day. When one thought that much of the progress of this country and of the world in general came from bits of iron and copper and glass assembled in old cupboards, he did not know anything more romantic. He only hoped that in the days to come there would be similar history around that building. Among the exhibits was a dynamo used at Changford for the first mill electric lighting installation in the British Isles, and examples of the early electrical gear employed by the Exeter Corporation's electricity department.

An African Air Survey.

IN previous Journal notes we have referred to a scheme by which the water from Lake Albert, on the borders of the Belgian Congo, would be brought down to the Nile by means of a canal in order to avoid the wastage of water which occurs by evaporation and absorption in the Sudd area. The two alternative schemes at present favoured are those of constructing a canal through the Sudd itself or alternatively of constructing a canal to by-pass that district entirely. Both schemes involve the construction of a big dam at the northern end of Lake Albert. The recent completion of an air survey of the region concerned extending on the west to the Bahr-el-Jebel and on the east to the borders of Abyssinia and covering an area of about 30,000 square miles will make it possible to base the alternative projects on a more solid footing than has hitherto been available since the information obtained as to the courses of old river beds and watercourses which might be utilised for the purposes of the proposed canal will be of great value. The work of photography occupied twenty months. The photographic mosaics have been delivered to the Egyptian Government, and when the maps have been completed reports on the alternative schemes will be prepared so that a decision can be made as to which shall be adopted. The survey was carried out by the Air Survey Company on behalf of the Egyptian Irrigation Department.

Reorganisation of the Cotton Industry.

AFTER many months of detailed study and investigation of the problems facing the cotton industry, the Joint Committee of Cotton Trade Organisations decided last Friday, December 11th, to put concrete proposals before the chief organisations interested. The Committee considers that some of the difficulties facing the cotton trade can best be met by the co-ordinated action of all sections of the industry. The difficulty which it is most urgently necessary at the present time to overcome is that of redundant machinery, and it is believed that the elimination of such machinery is an essential condition for any return to sound and profitable trading. In all there are, at present, in the country about 57,000,000 spinning spindles and 700,000 Lancashire looms, and the Committee considers that about one-fifth of these spindles and looms were inoperative at the end of June this year, while the remaining plant was not working at full capacity. The recommendation is therefore made that statutory trustees should be appointed to work in agreement with assessors representing interested sections of the trade to buy out of production about 10,000,000 spindles and 100,000 looms. The cost is estimated to lie between £2,500,000 and £2,750,000, and that sum would be raised on a loan secured by levies on the firms in the industry at a rate not exceeding 3d. a spinning spindle and 7s. 6d. a loom a year. The scheme is to be submitted to the associations and organisations competent to deal with it for their comments and approval.

The Laws of Ship Resistance.

By G. S. BAKER.

No. V.*

Width of Channel.—Schütte has tested several forms in channels of varying width and depth. With a cargo boat the increase in resistance at any speed over the open water value was approximately the same for a broad and shallow channel as for a narrow and deep channel, provided the ratio $\frac{\text{depth of water}}{\text{draught of ship}}$ in the former and $\frac{\text{width of channel}}{\text{beam of ship}}$ in the latter was the same. This only applies to the non-wavemaking speeds at which such a vessel would run. At higher speeds experiments with models of a liner and a torpedo boat show the resistance humps, and the succeeding hollows become more emphatic the narrower the channel. Table XVI. gives the percentage increase in resistance found with these two models. At low speeds these increases are of the same order as for the same degree of restriction on the depth, given in Fig. 13. The data, however, are not very accurate, being obtained from small-scale diagrams, but they serve to show that a width of channel of at least eight beams is required for the liner and ten beams for the torpedo boat to get the same results as in deep water. The data for actual ships travelling in a canal are very meagre. The results obtained with some twenty vessels in the Suez Canal have been analysed as completely as possible. These were all large merchant vessels, of the cargo or intermediate class, with prismatic coefficients varying between 0·75 and 0·65, and draught from 22ft. to 27·5ft., the depth of water in the canal being 34ft. to 36ft. There were considerable variations in the results, but Table XVII. represents the average of the whole. The losses quoted are for speeds usual in the canal—5·0 to 7·5 knots—the higher speeds for the shallower draughts or smaller midship sections. It should be noted that in the canal the forward wake at the stern is high and turbulent, and that with the lower speed the propellers are working at a much higher slip. For both these reasons the efficiency of the propeller will be lowered, and the power required to turn the propeller will be more than with the same revolutions in deep water. Part of this loss of speed is due to poor steering, an erratic course involving much loss in streamline energy. Tests in the Suez Canal showed that the rudder should swing into the propeller race—where the flow velocity is high—at an angle of helm of 10 deg. for good and 15 deg. for reasonable steering.

Some tests were made by Gebers in which a number of similar models of different sizes were tried in two canals, with the following results :—

With a canal section twenty-three times that of a fine-lined hull the resistance was increased 12 per cent. at speeds well below $\sqrt{5 \cdot 3\, d_g}$. With an unusually blunt bow the increase rose to 20 per cent., and in both cases the increase was abnormal above the speed given. With a canal section fifty-one times that of a fine-lined hull the increase of resistance was roughly 8 per cent. at low speeds. When the canal section was 200 times that of the hull it had no effect except when approaching the speed of the wave of translation for the depth, when the resistance was increased 3·0 per cent. for a fine and shallow form (B/D=4·0) and 10 per cent. for a deep section form (B/D=1·0). One may conclude from these and other tests quoted that to avoid boundary effects the ratio of section of canal to the midship section of a hull should be about 150 for low speeds, increasing to at least 200 for high speeds.

Barge Canals.—In the case of inland canals the type of hull used is very different, belonging generally to the barge class. The form is much fuller, always in the region of 0·9 block coefficient, and the speed quite low, usually 3·0 to 4·0 miles per hour, and it is only results at these low speeds that are of practical interest. The best data are those obtained by Monsieur de Mas, and the following notes are based on his tests with full-sized barges in various canals :—

(1) Canals which are broad and shallow give worse results than deeper and narrower ones of the same sectional area. A barge of draught 4·5ft. to 5·0ft. requires at least 1·5ft. and, if possible, 2·0ft. of water under it, if it is to keep a steady course and avoid a very high resistance due to the squat of the vessel in consequence of the steady flow under the bottom.

(2) Any advantage due to form which a barge may possess in deep water is partially masked, but not obliterated, in a canal.

(3) The resistance in a canal depends very largely on the ratio $\frac{\text{area of canal section}}{\text{barge midship area}}$. The excess resistance in a canal over that in deep water may be written in the form

$$(R - r) = 9 \cdot 5\, A_m \left(\frac{v}{n-1}\right)^2$$

R and r being resistance in pounds in shallow and deep water respectively, A_m is the immersed midship area in square feet, n is the ratio of areas given above, v the velocity in geographical miles per hour.

A curve representing this equation is given in Fig. 14, together with the experimental data on which it is based. The curve is for full-form barges towed on a long wire and is reasonably accurate for speeds up to 2·3 miles per hour. If the barge has not the clear water mentioned in (1) above, its resistance will be materially above the curve, especially if n is below 5·0. The excess resistance arises from the difference in the level of the water ahead and astern of the barge, and the turbulence set up around the sides and bottom as the water moves aft and across the stern of the barge. The dimensions of the barges used in the tests, together with their resistance factors in deep water, are given in Table XVIII. Included in this table are some later results with English and American barges. In comparing these it should be noted that all the Thames types were tested in the race of the tug propeller, which adds considerably to the resistance, and that the "Sadler" forms had no budget plates aft.

The three vessels "Alma," "Rene" and "Adrien," were all of the same type and same cross section, but of different lengths. Thames types D and E varied in the same way. Beaufoy found that two box forms 3·5ft. by 1·2ft. in cross section of lengths 42ft. and 21ft. respectively had resistances when towed on a wire roughly in the ratio 1·2 to 1·0 at all speeds from 1·0 to 7·0 m.p.h. All of these results go to show that the resistance of the long barge will be the same or only slightly more than that of the shorter one, the extra displacement in the longer one being carried for almost nothing.

The first effect of lightening a barge is to make the resistance constant slightly worse, but judging from the "Sadler" forms it improves in the extreme light condition.

The easing away of the sharp corners at the bow and stern—compare types D and A, also the "Toue" boat and the "Peniche"—improves the resistance by about 30 per cent. for the same displacement. This drop in the tow rope pull also allows the tug screw to work more efficiently and the total gain in power from such a change is 40 per cent. Thus the I.H.P. required to tow four type A barges is $3 \cdot 6\, V^3$ in deep water, and for four type D barges is $2 \cdot 5\, V^3$. The outlines of these barges and of the Sadler 4 and 8 are given in Fig. 15. In deep water the best way to arrange a train of barges is with one in front, then one or two pairs, finishing with a single. This decreased the tow by 14 per cent. with the Thames barges, and still more with some of the Sadler barges.

These model results are confirmed by towing tests recently carried out on the Thames. Two type A barges and, later on, two type D were towed in the same manner by the same tug, both being fully loaded. The type A barges required 137 I.H.P. with a tow pull of 3·77 tons to maintain 4·36 miles per hour, the type D required 132 I.H.P. with a tow pull of 3·2 tons and maintained 5·75 miles per hour, a gain of some 30 per cent. in speed.

If the barge is to be self-propelled, a Sadler 8 but with finer stern, is the best. The propeller should be as far aft as possible, and the shaft line kept low, consistent with as large a diameter for the propeller as the engine revolutions and the depth of the water will allow.

When the barges are in a wide and shallow river, taken singly, in pairs or long train, types D and E and Sadler 8 give good performances. But for a train of six barges, each *close* behind the other, Sadler 4 on a long wire becomes as good as 8 or 2 in water of depth 6ft. to 8ft., although if used as single barges in this depth of water it is nearly 70 per cent. worse than the Sadler 8. This relative gain of the type 4 in a long train is probably due to the very small space left between consecutive barges when they are parallel sided and full at the ends, so that eddies cannot be formed between them, and one secures the advantage of a long barge, as shown by Table XVIII.

The effect of depth of water varied with the manner of arranging the barges. Results are given in Table XIX. for one, two, three, and six barges in three depths of water. A long train is materially better than a broad one, and it is always better to

TABLE XVI.—*Effect of Width of Channel.*

Vessel.	Number of beams in width of channel.	Percentage increase of resistance at P of							
		2·0	1·75	1·5	1·25	1·0	0·9	0·8	0·7
Torpedo boat	3·4	7·0	16·3	7·5	32·0	9·5	9·5	—	—
Block coefficient 0·45	5·7	1·6	8·0	5·1	12·0	7·4	7·0	—	—
Prismatic coefficient 0·60	7·9	0·4	1·6	—	4·7	2·5	1·5	—	—
Liner	3	—	—	—	—	20·5	26	16	9
Block coefficient 0·61	5	—	—	—	—	1·5	6·5	4·0	4·0
Prismatic coefficient 0·64	7	—	—	—	—	—	3·0	2·0	—

NOTE.—The bad wave-making speed of the torpedo boat in deep water is P = 1·5. The highest service speed of the liner is P = 0·8.

TABLE XVII.—*Loss of Speed Passing from Deep Water to Canal, Engine Making the Same Revolutions in Both Cases.*

Area of canal section / Ship midship area	5·0	6·0	7·0	8·0	9·0	10·0
Percentage loss of speed	41	29	21	15	10	7

TABLE XIX.—*Barge Resistance in Wide Shallow Water.* Length 150ft., draught 4·0ft., A_m = 136 square feet, displacement 460, block coefficient 0·79. Values of the resistance contant $\frac{r}{A_m v^3}$.

Arrangement of barges.	In deep water.	Water depth 9·0ft.	Water depth 6·0ft.
Single barge	0·45	0·56	0·65
Two abreast	0·43	0·78	1·30
One in front, two abreast close behind	0·41	0·58	0·81
Three pairs of two	0·37	0·45–0·50	0·46–0·52

TABLE XVIII.—*Dimensions of Barges and Values of* $\frac{r}{A_m v^3}$ *in Deep Water.*

Type of barge.	Length, feet.	Draught, feet.	Cross-section area (A), sq. ft.	Displacement, tons.	Block[1] coefficient.	$\frac{r}{A_m v^3}$ per barge	Manner of tow.
Prussian	112	4·27	69	200	0·93	0·54	
Toue	118·4	3·28 4·27 5·25	54 70 86	— 226 —	— 0·95 —	1·0 0·88 0·84	Single on long rope
Alma	124	5·25	86	286	0·94	0·86	Single on long rope
Rene	99	5·25	86	226	0·93	0·86	Single on long rope
Adrien	67	5·25	86	148	0·91	0·86	Single on long rope
Peniche[4]	125	5·94	97	337	0·97	1·50	Single on long rope
Flute	123	4·82	79	256	0·93	1·05	Single on long rope
Jeanne	99	3·28 4·27 5·25	53 70 84	Same class	as Flute	0·85 0·86 0·82	Single on long rope
Thames barges type "A"	85[3]	8·0	150	270	0·74	0·68 0·64	In two pairs of two In three pairs of two — Towed by single-screw tug. Front of tow close under stern of tug
Thames barges type "D"	85[3]	8·0	155	270	0·72	0·45 0·45 0·40	In two pairs of two In three pairs of two In order 1, 2, 2, 1 — Towed by single-screw tug. Front of tow close under stern of tug
Thames barges type "E"	118[3]	8·0	150	375	0·74	0·50	In two pairs of two — Towed by single-screw tug. Front of tow close under stern of tug
Sadler Nos. 2 and 8[2]	100	4·67 1·00	106 22	247 45	0·82 0·73	0·25 0·23	Single barges with long tow rope
Sadler No. 4	100	4·05 0·87	92 20	247 45	0·94 —	0·60 0·50	Single barges with long tow rope

[1] Taken on overall length in all cases, light and loaded.
[2] Sadler No. 2 is similar at the end to Thames type "A."
[3] Length on L.W.L., 78ft. type "A" and "D," 110ft. type "E." Outlines of types "A," "D," "E" and Sadler Nos. 8 and 4 are given in Fig. 15.
[4] Peniche is rounded at each end, sides and bottom.

* No. IV. appeared December 11th.

have a single barge in front—see also Table XVIII. for similar results from similar tests in deep water. When there is a current in the river there is a speed of

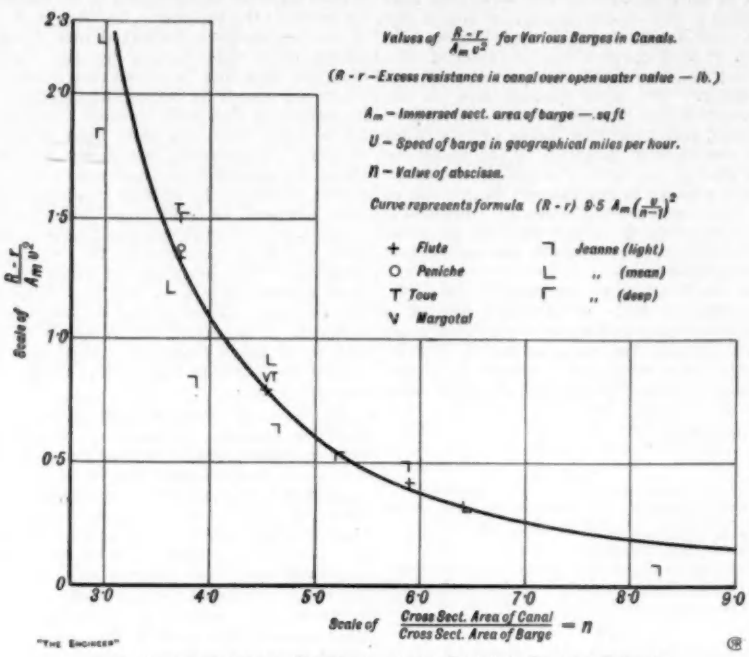


FIG. 14—ADDITIONAL RESISTANCE IN CANALS—BARGE FORMS

tow upstream which gives the minimum expenditure of energy per mile travelled. This speed is 1·5 times the velocity of the current, *i.e.*, a velocity over land one half the velocity of the current of the opposing stream. This becomes important only on rivers with fairly rapid currents.

Form of River Vessels with Screw Propulsion.—In general these have rather high ratios of both beam to length and beam to draught, and their speed is fairly high for their length, so that reasonable progress can be made against a heavy current. In a general way the rules which govern the form of normal deep-water ships apply to these broad vessels, but some special points arise with them.

Deck space is usually an essential quality, and to secure it there is a tendency to use large angles in the entrance. For fairly full vessels working at a P below 0·5 this can be done without great loss, and a scow or spoon-shape bow with entrance angles on the L.W.L. up to 50 deg. can be used. Thus a model of prismatic coefficient 82, with a beam of 72ft., draught 20ft., having a very convex bow load line with angle of entrance 44 deg., and long spoon bow, was 8 per cent. better than a similar form with 31 deg. for entrance angle and very U-shaped sections, at all speeds up to P of 0·45. In such cases it must be recognised that since the water at the bow must pass aft, and since with such an angle it cannot proceed around the sides, it must go under the bottom. In other words, the bow lines must be slanted back at a long easy angle and all bilge corners cut away, the necessary length of entrance being secured in this way, rather than on the load line. But when the speed exceeds that of the hump at P=0·67, this can hardly be done, and the whole idea of getting the water under the bottom at the fore end must be given up, the form be given a fine entrance angle, and be generally treated as a normal speed vessel. Two illustrations of the use of fine angles entrance are models 237 and 238—Table XX. Both of these have a long hollow entrance, and give good results at all moderate speeds. If the load line is straightened out at the bow the result is considerably worse, as shown by model 239. If larger angles are used the result again becomes worse, as shown by models 240 and 241, at their moderate speeds—these are too full in any case for speeds above P of 0·7.

To obtain deck space, the designer can use very great flare at the bow, starting immediately above the load water line, or greater beam amidships, as in the change from model 241 to 240, where the larger beam is carried with less resistance owing to the finer ends. If wider beam is not possible, then the centre of buoyancy should be taken aft rather than use a full bow.

The draught should always be kept as large as possible. Thus model 242 at 16ft. draught carries 10 per cent. more displacement than model 240. At a speed of 14 knots, or $\frac{V}{\sqrt{L}}=0{\cdot}7$, the P values are 0·63 and 0·68 for 240 and 242 respectively, and the C values are 1·03 and 0·84, or this extra 10 per cent. displacement is carried with 14 per cent. less resistance, with the deeper draught and finer ends.

Variation of draught by lightening the vessel, in forms of reasonably correct proportions for their speed, as a rule gives slightly larger C at the larger draught at high speeds, when the entrance angle increases with draught, as in model 242. With full forms and lower speeds the increase of C occurs with the lighter draught, as shown by model 243 in Table XXI. This holds generally, as long as the ratio of beam to draught is not too severe, but when the draught is less than about one-eighth of the beam, any further decrease causes a big increase in the C at low speeds, which is too severe for any gain from wave-making at the higher speeds to cancel it out. This increase in C is largely due to the fact that most of the frictional resistance arises from the bottom surface. Even the large change of draught represented by the two conditions of model 244 changes the wetted surface by only approximately 8·0 per cent., the displacement being changed

TABLE XX.—*Effect of Fine Entrance, Shallow-draught Steamers, Mid. Sec. Coefficient 0·96 in all.*

Model.	B.	D.	Prism. coefft.			Length of			Ang. entr.	C at P of				
			Entr.	Run.	Total.	Entr.	Run.	Parl.		0·6	0·7	0·8	0·9	1·0
237	56	10	0·55	0·57	0·56	200	200	0	9·7	0·73	0·73	0·78	0·82	0·88
238	46	11·5	0·60	0·57	0·64	175	170	55	10·0	0·71	0·73	0·77	—	—
239	50	11	0·62	0·67	0·64	206	194	0	11·0	0·78	0·81	0·85	—	—
240	78	12·5	0·64	0·66	0·69	175	175	50	23	1·0	1·07	1·29	—	—
241	76	12·5	0·66	0·68	0·71	175	175	50	27·5	1·07	1·25	1·45	—	—
242	78	16	0·52	0·68	0·59	220	180	0	14·5	—	0·84	0·93	1·02	1·20
242	78	20	0·53	0·71	0·62	220	180	0	16	—	0·84	0·94	1·03	1·26

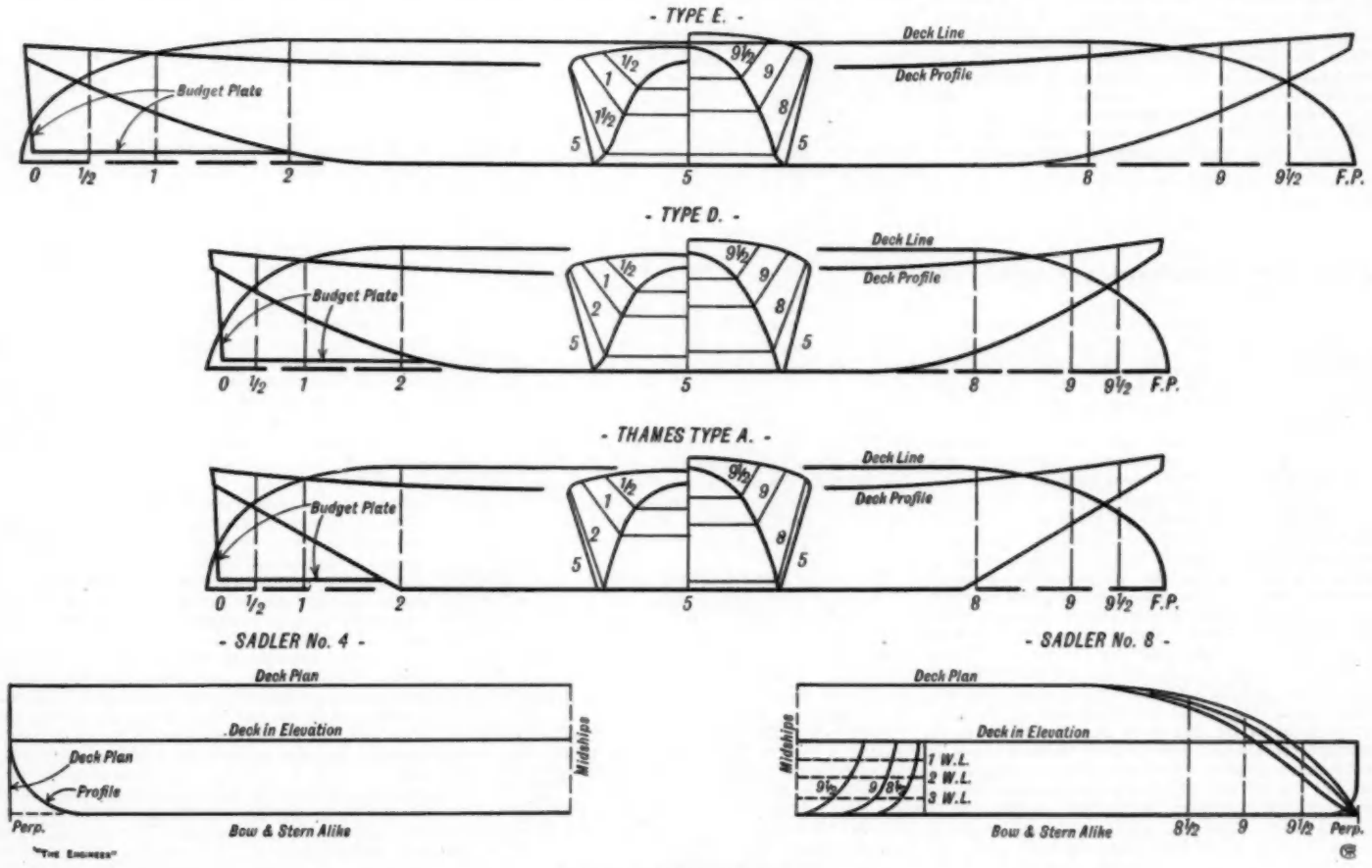


FIG. 15—BARGE FORMS

by 60 per cent., so that the wetted surface per ton displacement is increased by over 50 per cent., which is partially reflected in the increased C at low speed.

After End.—It is most desirable to have the water plane of the after end sufficiently wide to give good cover to the propellers, and such a L.W.L. has no objection from a resistance point of view. Since the buttock lines are easier in curvature than the levels, the main stream flow in the after body will tend to follow them, except close to the side. The angle of the cut up should not be greater than 15 deg. at any point in slow and 12 deg. in fast shallow forms, toning gradually into the flat bottom amidships and flattening out at the stern, so that from the propellers aft it is nearly horizontal. Towards the sides the angle should diminish a little, with easier buttocks along the whole after body, so as to allow the side water to move in towards the screws. The effect of tunnels on the resistance depends somewhat on how they are combined in the design. In many cases the tunnels are long, straight, slanting grooves of constant radius in cross section, joining the side and bottom with a definite edge. In these there is a loss of displacement which may rise to as much as 8·0 per cent., which for given displacement means a fuller form or larger dimensions. The increase in C due to the tunnels for such forms in deep water varies from 10 per cent. at low to 6·0 per cent. at high speeds. If, however, all the corners and edges are swept away, the tunnels opening out as they meet the bottom, having a sort of funnel entry, and the cross sections being everywhere rounded, the C is increased only 1·0 or 2·0 per cent. by such tunnels. The case of the "well" in the fore body of a dredger is somewhat similar to these tunnels. Such wells add materially to the resistance of the dredger, even with the line of buckets hoisted inside the "well." The rear of this well is usually a vertical bulkhead extending down to the keel level. But if the rear lower end of the well is opened out, particularly fore and aft, giving it a long-curled lip which gradually works into the flat bottom, with the lip continued inside the well by a slanting guide plate, the resistance can be diminished some 10 per cent. in most cases. The end achieved in both these cases is the same—the elimination of eddy-making at the corners. In the case of the tunnels these constitute an extension of the length of run in some forms; hence the diminution of their extra resistance at the higher speeds.

When the speed is higher than a P of 1·0, the general rules for Channel steamers must be followed. To secure fine angles on the entrance water line, the maximum section must be placed well aft of the mid-length, as it is better to sacrifice a little length aft than to use a large entrance angle at these speeds.

(To be continued.)

TABLE XXI.—*Variation of Draught on the Same Form.*

Model.	Beam.	Dra'ght	Prism. coefft.			Length of			Ang. Entr.	C at P of						
			Entr.	Run.	Total.	Entr.	Run.	Parallel.		0·4	0·5	0·55	0·65	0·7	0·75	0·80
243 ..	58·5	14·7	0·74	0·68	0·78	160	140	100	30	0·74	0·82	0·86	—	—	—	—
	58·5	13·7	0·73	0·67	0·77	160	140	100	29	0·77	0·84	0·87	—	—	—	—
244 ..	64·0	7·2	0·68	0·59	0·68	200	156	44	17·7	—	—	—	1·12	1·21	1·26	1·30
	64·0	4·8	0·66	0·58	0·655	200	156	44	17·3	—	—	—	1·3	1·34	1·37	1·39

Institution of Mechanical Engineers.

A CROWDED attendance marked the presentation, on Friday of last week, before the Institution of Mechanical Engineers, of Mr. Raymond Carpmael's paper on "The Manufacture and Use of Steel Railway Sleepers." Elsewhere in this issue we begin a reprint of this paper.

Sir John A. F. Aspinall, opening the discussion, said that since he spoke on the subject thirteen years ago much spade work had been done in connection with the use of steel sleepers on British railways, and an earnest endeavour had been made to realise the important advantage which, he remained convinced, their employment would secure to this country. Passing on to consider the various types of steel sleeper described in the paper, he remarked that the "G K N" pattern illustrated in Fig. 10 appeared to be a strong piece of work. The chairs had fine bearing surfaces on the sleeper, and the sleeper as a whole should give a good account of itself on the road. Its total weight, 242 lb. with the chairs, was, however, considerable. He would like to know whether the four oval holes for the cast iron snugs or rivets weakened the sleeper and made it liable to bend in their neighbourhood. The Sandberg pattern illustrated in Fig. 13 was a fascinating and clever design, but it involved perforating the channel section and, he was afraid, the structure, as a consequence, would be weakened. The Ebbw Vale single unit type of sleeper shown in Fig. 15 weighed 56 lb. less than the "G K N" A saving of half a hundredweight per sleeper would represent a very big tonnage saving on a mile of road. The figures for the relative costs of steel and wooden sleepers given by the author were apparently based on the cost of "G K N" sleepers. They were therefore higher than some people were accustomed to postulate. What was the experience on the point of other railway engineers? Could they confirm the Great Western figures? Under favourable circumstances steel sleepers could undoubtedly have a long life. He knew of some which, in spite of ballast and drainage conditions which were not too good, were still in service after a life of forty years. In Holland, as Mr. Carpmael had stated, some steel sleepers were still in use after service for thirty-four years. Continuing, he remarked that the author's contemporary history of the steel sleeper required re-writing. No such history could be complete if it omitted to mention the work on the subject done by the late Mr. James Livesey, the inventor of the cast iron pot sleeper—which was still used on many thousands of miles of railway—and of the pressed steel pot sleeper. The stirrup or twin bolt type of sleeper illustrated in Fig. 5 was a very good pattern for flat-bottomed rails. Only once in the course of many years' experience had he encountered corrosion between the foot of the rail and the top of the sleeper, and in that instance he traced the trouble to the failure of the permanent way staff to keep the nuts and bolts properly tightened. There were many designs of steel sleepers for flat-bottomed rails. For fifty years endeavours had been made to produce one that was wholly satisfactory. It was therefore easy to understand why British railway engineers found it difficult to arrive at a good design of sleeper for bull-headed rails. The Sandberg and Ebbw Vale designs were attractive, but it would be interesting to see whether it would be found possible to keep the keys tight. In Switzerland 60 per cent. and in Germany 38 per cent. of the track was laid with steel sleepers. If 38 per cent. of our track were similarly laid there would be involved the use of three or four million tons of steel, the supply of which would prove a nice little addition to the activities of the steel industry. The specification for material for steel sleepers given by Mr. Carpmael should not be taken as final until the figures had been authorised by the British Standards Institution. He was quite satisfied in his own mind concerning the great importance of dipping steel sleepers. If the proper temperature and the proper mixture were used the coating would adhere firmly. The steel sleeper forty years old, to which he had referred, still possessed its original coating, except at one point. The British Standards committee of which he was Chairman had now standardised plates for the manufacture of steel sleepers. The specification of such plates by users would greatly assist the manufacturers.

Mr. George Hicks said that on the Burmah Railways 17 miles of steel sleepers had been in service for the past eighteen years. The condition of the sleepers was still as good as new. They were laid in the hill section, where the speeds were low and the drainage was good. The only difficulty that had been encountered with them was as regarded the preservation of the alignment on the inclines, which varied from 1 in 40 to 1 in 25. In Burmah they had an excellent supply of timber for sleepers, on which they could count for a life of fourteen years and upon which the white ant could make no impression. They would therefore probably continue to rely mainly on wooden sleepers for a long time to come. The object of using steel sleepers was to keep down the price of the wooden supplies. Steel sleepers were certainly satisfactory in dry districts. They had tried them on a soft bank in South Burmah in a district which experienced 260in. of rain between May and October, but had not found them satisfactory.

Mr. Charles J. Brown, of the L.N.E. Railway, said that most of the companies were now experimenting with all the approved types of steel sleeper. The general view was that there should be no holes in the sleeper and that there should be no means of access of moisture to the rail seat. On the question of the life of wooden sleepers, he stated that it might be even longer than that named by the author, and as regarded their cost, he stated that it might be reduced by 2s. per sleeper by buying them in bulk. Altogether he estimated that steel sleepers might cost anything up to £300 more per mile than creosoted wooden sleepers. Concerning Sir John Aspinall's remark about the benefit from the traffic point of view that would accrue to the railway companies by the use of steel sleepers, he said that more traffic would be created, but the railways would have to pay for it and they would in that respect be living on their own washing. The problem of track circuiting when steel sleepers were used was undoubtedly a difficult one to solve. It definitely limited the use of steel sleepers. If a portion of the line with steel sleepers had to be track circuited it would be necessary, to obtain the requisite insulation, to relay the line with wooden sleepers.

Mr. W. A. Clarkson, of Guest, Keen and Nettlefolds, made a pleasing reference to the assistance and encouragement which the late Mr. J. P. Bailey, of his firm, had received from the Great Western Railway, and from Mr. Carpmael in particular, in the development of the "G K N" type of sleeper. Without that help the use of steel sleepers on British railways would not have advanced as far as it had done. The increased use of steel sleepers would be of vital assistance to the iron and steel industry.

Mr. R. W. Foxlee (Crown Agents for the Colonies) remarked that in none of the types of steel sleeper now being tried on British railways was it possible—or so it seemed to him—to remove a sleeper from the track without taking up a whole rail length. What, he asked, did the author do if he got a broken jaw on one of the "G K N" sleepers? Did he smash the other chair and replace the sleeper with a wooden one carrying cast iron chairs? That might be possible, but what was the corresponding procedure in the case of the Ebbw Vale unit design? It would be impossible to remove the ballast and drop the sleeper down. The only method seemed to be to remove the rail length. He would also like to know what method the author adopted in order to widen the gauge at sharp curves. Were special sleepers adopted at such curves? With flat-bottomed rails, steel sleepers could be used that permitted the gauge to be widened by ¼in. or ½in. at sharp curves, but with bull-headed rails the provision of such means of adjustment on the sleeper was much more difficult. Mr. Carpmael, he thought, was rather severe on those types of steel sleeper in which the attachment of the chair to the sleeper was effected otherwise than in a permanently rigid manner. He need have no fear in that connection. In West Africa on a line using flat-bottomed rails, no tendency for the fastening bolts to work loose during the first six months of service had been noticed. From the figures given by the author it appeared that of the cost of a "G K N" sleeper complete with cast-on chairs—namely, 15s. 6d.—some 5s. or 6s. represented the cost of the fastening. It was a large figure to pay merely for a means of attaching the rail to the sleeper, and it was there, he thought, that the money was being spent uneconomically. With flat-bottomed rails the cost of the fastenings was only about 1s. 9d. to 2s. per sleeper. In a wooden sleeper, he pointed out, the chair was employed to attach the rail to the sleeper and to distribute the load on the rails over the sleeper. In steel sleepers there was no need to distribute the load, and therefore 5s. or 6s. seemed a heavy price to pay for something which served merely to attach the rails to the sleeper. The flat-bottomed rail was primarily designed to assist in the distribution of load over the sleeper, and therefore from that point of view was not best adapted for use on steel sleepers. He believed that an improved rail could be designed which would be particularly suited to use on steel sleepers, and which would permit the cost of the sleepers to be reduced by about 3s. apiece.

Professor G. Lomonossoff said that from the standpoint of the usual theory of structures, a sleeper was a beam lying on an elastic bed, and acted upon by two concentrated loads. From the point of view of railway mechanics, however, it was one of the links in the elastic chain which connected the superstructure of the vehicles with the earth. In that chain the action of each link depended not only on its own properties, but also on the properties of the other links. Consequently, the permanent way should be considered, as regarded cost of maintenance, in conjunction with the cost of maintenance of the vehicles. Photographic observations made in many countries showed that the amount by which a wheel sank in rolling along a rail was the sum of three factors, namely, (*a*) the amount by which the bottom of the sleeper sank, (*b*) the compression of the sleeper and (*c*) the deflection of the rail. The compression of the rail was negligible. For modern heavy rails, the deflection was usually less than 0·003in. For wooden sleepers the compression factor varied from 0·03in. to 0·04in., while for steel sleepers it was less than 0·001in. The sinking of the bottom of the sleepers varied from 0·12in. to 0·4in. Observation also showed that on a properly maintained line with

wooden sleepers the wheel received vertical impulses only at the rail joints. The compressibility of wooden sleepers played as regarded the permanent way, the same part as did the springs on the vehicle. It softened the impulses arising from the inevitable irregularities in the elastic properties of the ballast. If the compressibility of the sleepers were zero, the wheel received vertical impulses, not only at the rail joints, but intermediately, and the frequency of its vertical oscillations increased and became irregular. A high-frequency vibration was harmful to railway vehicles. In addition, if the compressibility of the sleeper were zero, the impulses received by it from the wheel were increased. Consequently, steel and ferro-concrete sleepers were subjected to a more intense vibration under the load of a passing train than were wooden sleepers. It was for that reason that ferro-concrete sleepers crumbled quickly in service, and that steel sleepers had to be made from very soft material. According to German practice, the breaking strength of steel for steel sleepers should be about 23 tons per square inch, and the elongation about 25 per cent.

Any prejudice which existed against steel sleepers had therefore a deep foundation. No one denied their safety, but they were not compressible, and consequently acted harmfully on the vehicles. If the traffic were light, that fact would have a negligible influence on the cost of a ton-mile, but if the traffic were heavy it had to be taken into consideration. On the German State Railways about 38 per cent. of the sleepers were of steel. The latest type had proved very satisfactory. Nevertheless, on main lines, with heavy traffic, wooden sleepers were still preferred. It was universally recognised that British railways had the best permanent way in the world. It might be that for economic and political reasons, they would be compelled to change its construction. It seemed to him, however, that any such changes should be made only very carefully, and after thorough investigation, particularly into the effect of steel sleepers on the wheel. At the National Physical Laboratory there existed an instrument for measuring the vertical acceleration received by the wheels of motor cars. Similar apparatus might be used for studying the corresponding problem on railways. It would also be useful to investigate the possibility of compensating the inadequate compressibility of steel sleepers by the use of elastic plates between them and the rail.

In Germany it had been found that steel sleepers must have the simplest possible form. Early elaborate forms had been found to crack longitudinally. He doubted whether some of the designs illustrated in the paper would not suffer from the same defect. All things considered it seemed to him that the wide adoption of steel sleepers would result in the abolition of the bull-headed rail.

Mr. B. G. Mason argued that even if British railways did use flat-bottomed rails none of the existing types of steel sleepers for such rails would meet the requirements of British railway engineers. The ideal steel sleeper for flat-bottomed rails had yet, apparently, to be produced. He called attention to the variation in the dimensions of the trough, and in the length of rail bearing in the jaws, which distinguished one steel sleeper from another. Speaking as a manufacturer, he would be glad to learn whether British railway engineers definitely desired to have the inside dimensions of the cast iron chairs used on wooden sleepers reproduced on steel sleepers. Discussing the type of steel sleeper in which the chair was welded to the trough body, he remarked that welding had been greatly improved recently and that a bad weld could now be detected as easily as a bad casting. He believed that with the assistance of railway engineers steel sleepers could be developed and perfected and would give every satisfaction.

Mr. W. A. J. Day stated that steel sleepers had been first tried on the South African Railways about forty years ago. They had not been found satisfactory; but some eight years ago the question had again been gone into, and since then about eight million steel sleepers had been put into service. They were being used on the strength of their own merits, and not because wooden sleepers were exposed to the attack of white ants. The design adopted was straightforward. Each sleeper had four holes and four bolts and clips. The clips permitted the standard gauge to be widened by anything up to ¾in. at curves. Flat-bottomed rails were used and nothing was inserted between the rail and the sleeper. Any sleeper could readily be removed from the track in the event of failure. The fastening details cost about 8d. per sleeper. In reintroducing the use of steel sleepers they had been mindful of the national standpoint, and of the fact that within a few years South Africa would be capable of producing her own steel sleepers. He admitted that the conditions in South Africa lent themselves more readily to the introduction of steel sleepers than those in this country. With a flat-bottomed rail one was already half-way towards the use of steel sleepers. With a bull-headed rail the necessity for welding on or otherwise attaching seats, lugs, &c., to the body made steel sleepers for such rails expensive. In South Africa, too, the narrow 3ft. 6in. gauge and the low maximum speed of about 55 m.p.h. encouraged the adoption of steel sleepers.

Mr. H. C. Muggeridge asked why the waisting at the centre of the first type of "G K N" sleeper—Fig. 9—had been abandoned in the later type—Fig. 10. It seemed to him desirable that waisting should be employed, for it would serve as a means of retaining the ballast where it was required, namely, beneath the rail seat. Again, it seemed preferable to him that the tilt given to the rail should be provided by a suitable bend in the body of the sleeper, and not, as was the case, by inclining the inner face of the cast iron chair. If the suggested alternative method were adopted, it would assist the sleeper to keep its position in the track after the manner in which a man resisted a pull by digging his heels into the ground.

Mr. A. H. Harvey, of the Ebbw Vale Company, discussing the relative costs of steel and wooden sleepers, said that steel sleepers would have to be made in large quantities before they could be produced economically. Each individual order for steel sleepers so far placed by the British railways had been relatively small in amount. With orders of sufficient magnitude to permit the adoption of mass production methods the cost of steel sleepers would be reduced to a figure comparing favourably with that of wooden sleepers. A single sleeper of the unit type could, if damaged, quite easily be removed from the track, and it was readily possible to make provision by means of inserted liners for widening the gauge at curves.

Mr. A. F. Webber gave some figures illustrating the satisfactory behaviour under test of the Dorman Long welded type of steel sleeper. Mr. J. E. James remarked that steel manufacturers had by no means said their last word on steel sleepers for bull-headed rails, and that if they were encouraged they would be able to produce cheaper and more efficient designs than any dealt with in the paper.

Mr. Carpmael, replying to the discussion, said that he had known only of one case in which the snugs in a "G K N" sleeper had broken in service. The cause of failure was traced to faulty casting of the chair. It was quite true, as Sir John Aspinall had suggested, that his estimate of the relative costs of steel and wooden sleepers was based on the cost of "G K N" sleepers. Twelve months ago, when he began the preparation of the paper, he had no information concerning the Dorman Long or Workington type of sleeper. He had now had two or three months' experience with the Ebbw Vale unit type of sleeper, and so far had found no tendency for the keys to work loose. He knew that Sir Brodie Henderson held strong views concerning the value of dipping steel sleepers, but, on the Great Western, they had some dipped sleepers which were already bare after only three years' service. Track circuiting certainly created a difficulty militating against the use of steel sleepers. He had already been compelled to remove some steel sleepers because the section on which they were laid had to be track-circuited. There was no difficulty in removing a damaged steel sleeper from the track without disturbing the rail length. The design of the chairs or seatings on the steel sleepers used on the Great Western provided the same inside dimensions as those of the standard cast iron chairs for wooden sleepers, and it was as easy to remove a steel as a wooden sleeper. A steel sleeper of the "G K N" type did not become scrap if the chair broke. It was returned to the works to have a new chair cast on to it. He agreed with Professor Lomonossoff's explanation of why ferro-concrete sleepers went to pieces. He knew that the French and Italian railways used them to some extent, but in this country it was found that they would not stand up to the punishment which they received. He had sought the opinion of drivers concerning the merits or demerits of steel sleepers from the running point of view, but found that before he could get an answer he would have to tell them which sections of the line were laid with steel sleepers. If the drivers knew where the steel sleepers were laid all they were able to notice was a slight "hardness" in the running of their engines. He entirely agreed with Mr. Mason concerning the recent improvements made in the art of electric welding. It was now used extensively in railway engineering for building up worn parts, on bridges, and for many other purposes. His paper was, however, written before he had had any experience with welded sleepers on the Great Western. Replying to Mr. Muggeridge, he said that the waisting of the earlier pattern of "G K N" sleeper had been abandoned because it was found that it did not do what Mr. Muggeridge had said it would accomplish, and because that being the case, the simpler non-waisted pattern was to be preferred. The tilting of the rail was secured in the chair rather than on the sleeper—because that was the practice followed with wooden sleepers. He agreed that mass production would reduce the cost of steel sleepers, but whether that cost would be as low as that of wooden sleepers would rest with the manufacturers. Broadly speaking, there was no difference in the noises produced by steel and wooden sleepers. In the "G K N" type there were no loose parts to rattle or chatter. In deep cuttings the "song" of steel sleepers might perhaps be a little louder and more metallic than that of wooden sleepers, but the difference was so slight that unless one were on the look-out for it, it could readily escape notice.

The Manufacture and Use of Steel Railway Sleepers.*

By R. CARPMAEL, M.I. Mech. E.

THIS paper could be commenced in no more appropriate manner than by the quotation of references made to steel sleepers in the Presidential Addresses to the Institution of Civil Engineers by Sir John Aspinall in 1918 and Sir Brodie Henderson ten years later. Sir John Aspinall said:—

"We may wonder whether the immense difficulties of obtaining sleepers from Baltic ports will in the future cause any change to be made in the material used for our sleepers, and whether steel will in any large measure take the place of wood. If the life of a steel sleeper is the same as that of a wooden one, the 300,000 tons of steel sleepers which would be required to replace the 4,500,000 wooden sleepers used each year by British railways would create a new steel manufacture for this country, using up our own pig iron made from native ores, in the numerous new blast-furnaces which have been started in this country during the war, and saving the purchase of foreign-grown timber. It is true that our cast iron chair does not lend itself readily to attachment to a metallic sleeper, and also that the earlier experiments with such sleepers were not altogether satisfactory; but since then a great development in the use of broken stone ballast, resulting in a well-drained road bed, has eliminated the cinder ballast which was so destructive to steel, and it may yet be possible to consider whether the flanged or Vignoles rail of large section easily attached to a steel sleeper may not come into use if the whole question is looked at from the broad standpoint of endeavouring to help and foster our home industries. Such a proposition would add to the work of our iron ore miners, keep our blast-furnaces going, find employment for rolling mills, and continuous and steady work for some classes of labour after the war. There is no reason, if such sleepers could be accepted, why absolutely standard dimensions should not be agreed upon, and their use might be as extensive in England as it is on the Continent to-day."

Sir Brodie Henderson referred in 1928 to steel sleepers in similar terms:—

"If prejudices could be overcome and steel sleepers employed, a very safe road would be provided, and many tons of steel could be used per annum, giving much-needed work to our steel manufacturers."

Sir John spoke with full knowledge of the weakness of a position resultant from failure of timber supplies due to enemy action; Sir Brodie with long experience of steel sleepers in South America and elsewhere.

Until comparatively recent times, British railway engineers were in a position to obtain ample supplies at economical rates of timber suitable in every way for track work. That this retarded experimental work on suitable substitutes for timber—for example, steel and concrete—is undoubted in the case of the standard bull-head track in use in this country. The more favourable conditions to which we have been accustomed are in no way comparable with those existing in many other countries. In tropical latitudes certain insect pests, such as the white ant, absolutely prohibit the use of practically every variety of timber, unless it is suitably protected against these ravages by creosoting or other similar processes, which can generally only be applied at prohibitive cost. Various other reasons curtail or prohibit the use of timber in certain cases, and call for the use of metallic or other suitable substitutes.

The earlier introduction of steel sleepers in our Colonies and in numerous other parts of the world was therefore of paramount importance, if not inevitable.

It would be well to examine at greater length the reasons for what Sir Brodie Henderson describes as the "prejudices" of British engineers against the use of steel sleepers in this country. Among these reasons the plentiful supply of timber was predominant. With our efficient system of creosoting, together with the pre-war cheapness of creosote—produced wholly as a by-product of home manufacture—timber has proved in the highest degree satisfactory as a source of sleeper supply.

When it is realised that the average life of a timber sleeper—creosoted—is some twenty-two years in main track, and that of those recovered from relaying, about one-half are of serviceable quality for re-use in secondary branch lines and sidings for a further period of ten or more years, the balance providing excellent material for fencing and general purposes, or producing considerable revenue for sale as firewood, the difficulty confronting steel manufacturers in producing an economical substitute will be appreciated. That the gravity of the problem was not appreciated by those not closely in touch with every aspect of the situation is shown by the publication in a well-known technical journal some few years ago of a leading article on the subject, in which it was stated the "good life of the ordinary British softwood sleeper in normal positions is said to be between ten and twelve years." Had such been the case, no railway engineer would have hesitated to find a more suitable material many years ago. It may be assumed that the statement referred to sleepers under flat-bottomed rails with no intermediate bearing plates. With a full knowledge and appreciation of the facts, can the hesitancy of the British railway engineer to introduce an untried and almost unkown material call for much adverse criticism?

Although often true, the French proverb, "C'est le premier pas qui coute," does not apply to steel sleepers. What matters most is the subsequent maintenance cost, including that of replacement. The saving per mile for every year for which replacement of track can be deferred represents about £120, equivalent on the Great Western Railway alone to an annual saving of nearly £22,000. Given a satisfactory life in track service, the steel sleeper has the advantage over the timber sleeper that it has a higher residual value, and can be remelted to produce sleepers of undepreciated quality.

Another reason which has delayed its adoption in this country is that the steel sleepers which have been extensively used for many years on the Continent and in numerous countries overseas, including our Colonies, were almost

* The Institution of Mechanical Engineers

all used with flanged rails, and the feeling existed, not only in the minds of our railway engineers, but in those of our steel manufacturers, that their extensive use in this country presupposed conversion from the bull-head to the flange type of rail. Without entering into the respective merits of these two classes of rail, and apart altogether from traffic difficulties, such a change would, with due regard to economies, be very protracted, and may without hesitation be ruled out as a practical proposal. Some years ago the author was asked by a manufacturer to place an order for steel sleepers. The latter did not realise, nor did he apparently attach much weight to the fact, that at that time it would have necessitated making the change from bull-head to flat-bottomed rails. Although steel sleepers had been extensively used for many years overseas, no reliable data existed applicable to our own requirements, particularly as to heavy axle loads and high speeds. With our proved experience of the extended serviceable life of timber sleepers, it was naturally felt that, unless there were reliable data of the life of steel sleepers under climatic and other conditions similar to our own, we could not without adequate reason embark on their use.

The war was primarily responsible for the change of attitude, although it was not until some years after its termination that serious consideration was given to the selection of a suitable substitute for timber. During the war the main source of sleeper supply was isolated, and although considerable use was made of home-grown timber, it gave results which were anything but satisfactory, even when creosoted. As a general rule, owing to the strictures on the use of this preservative, clean timber was used. The railway companies are still suffering from the expense incurred in the premature removal of such timber, which proved to be thoroughly unreliable in service. The price of creosote has substantially increased over pre-war figures, and as this, too, is a factor of primary importance in the economical maintenance of track, it has hastened the extensive trial use of steel sleepers.

The situation was aggravated by the depletion of forests during and subsequent to the war period. For many years the rate of depletion has been greater than that of replacement by afforestation, a state of affairs which must sooner or later result in shortage of supplies, with consequent increase in price. Faced with this position, British railway engineers could look in only two directions for alternatives to timber, namely, ferro-concrete and steel. Of these, with full knowledge of the somewhat extensive use made of ferro-concrete sleepers in France and other continental countries, the author has no hesitation in saying that a substitute for timber more satisfactory than ferro-concrete must be found. Radical improvement must be made in the design, composition, and manufacture of ferro-concrete sleepers before they can be relied upon for general use. Restricted to steel as the only practical alternative, difficulties previously considered insuperable were faced by both engineers and manufacturers, and have been to a very large extent—one hesitates to say altogether—met.

Historical.—So far as can be ascertained, the use of metal sleepers dates back to 1849. These, however, were of longitudinal type, and it was not until 1860 or thereabouts, that trials were first made of the metal sleeper now known to us as the "cross-sleeper." The first use of such sleepers in England dates from 1863, when the Great Eastern Railway experimented with some of trough section with welded-on jaws to suit double-head rails.

In 1864 a type of cross-sleeper plate, not altogether dissimilar to that now used and known as the Vautherin type—Fig. 1—was introduced and first used on the Paris, Lyons and Mediterranean Railway. Owing to its shape, and particularly to the broad feet, an unsatisfactory bearing on the ballast was obtained. The principal defect of this type was the fastenings, which constantly worked loose, whilst frequent driving of the keys split the sleepers through the key hole.

In 1865 some 10,000 iron sleepers were laid on the Netherlands State Railways. The section was that known as Cosigns, and use was made of oak bearing blocks between the rails and sleepers. It is interesting to record that in 1899, after thirty-four years' service, during which 200,000 trains passed over them, the sleepers were in such a condition as to justify the renewal of the oak blocks to obtain the ultimate life of the sleepers. The records state that the annual renewal cost of the rail fastenings was lower than that of those with oak sleepers. Apart from this, which might be described as a combination timber-metal sleeper, serious consideration of the use of the all-metal rolled railway sleeper dates from the years 1880–1881.

It would cover too great a field to endeavour to describe in detail the many experiments which have proved the real practical value of the all-metal sleeper, but mention must be made of the methodical tests undertaken in 1881 on the Netherlands State Railways by their chief engineer, Mr. J. W. Post, under very practical conditions.

These tests were undertaken with the object of obtaining comparable data of the relative advantages of timber sleepers and those of various rolled metal patterns with alternative attachments of rail to sleeper plate. The sleepers which gave the most satisfactory results were those which, with due allowance for modern demands for increased speed and more commodious rolling stock with heavier axle loads, were of a design fairly comparable with those in extensive use in many parts of the world to-day. These satisfactory results led to extensive continental use, and, at a later date, use on the railways of Africa, India, and the Crown Colonies of sleepers of this type, the general arrangement of which is shown in Fig. 2.

These trials proved that the wear of rail and sleeper is largely dependent upon secure and rigid attachment of the one to the other, and that where such obtains, wear of the sole of the rail—in this case the flat-bottomed rail—and of the top of the sleeper, as well as that of the bolt holes and washers, is reduced to a minimum. The importance of this conclusion will be fully appreciated by British railway engineers, whose sole concern is the adequate support of the bull-head rail, and further attention will be directed to it.

The reduction in the size of feet or their substitution by bulbs appears to date from the late 'seventies, when the clip and bolt fastenings were also introduced. These changes originated in Germany, where in 1881 the Prussian Rhenish Railway was using the arrangement shown in Fig. 3.

In 1884 the late Sir Alexander Rendel designed steel cross-sleepers with pressed-up lugs and steel keys—Fig. 4. He introduced them on the Mexican Railways in that year, and in the following year on the Indian railways, thus initiating the use of a type which, with some modifications, India has perpetuated to this day and still continues to use. The use in the Crown Colonies of steel sleepers did not commence until about 1896, when the pressed-up lug and steel key type was adopted. In 1890 Sir Alexander Rendel designed and used on the Mexican Southern Railway a sleeper of the stirrup bolt type—Fig. 5—which, since 1905, has been extensively used by Messrs. Livesey, Son and Henderson in South America.

To allow for adjustments, particularly when laying switch and crossing work, the round-hole loose-jaw pattern—Fig. 6—was adopted in 1920. This type of fastening has given complete satisfaction in service, and extensive trial lengths have within the last three to four years been laid down on the Continent and in India.

For reasons already given, the experimental work carried out in England was not, until recent years, extensive. In 1880, however, the London and North-Western Railway experimented with steel sleepers known as Webb's pattern. These were 9ft. long, of the section shown in Fig. 7, 11in. wide by 2¼in. deep, and open-ended. Special pressed jaws with liner plates to form seats for

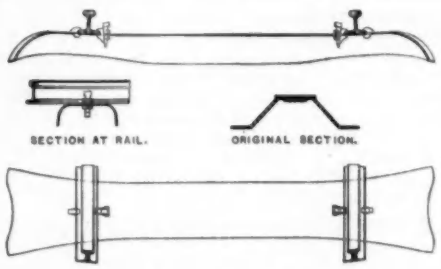


FIG. 1.—*Vautherin Type (Southern Mahratta Railway).*

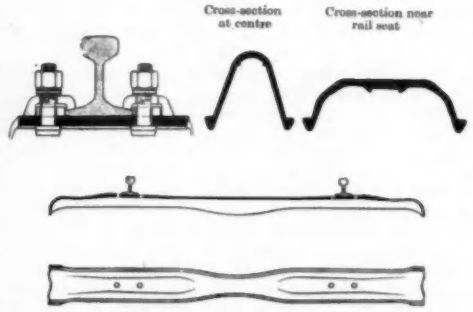


FIG. 2.—"*Post*" *Type (Netherlands State Railways).*

"THE ENGINEER"

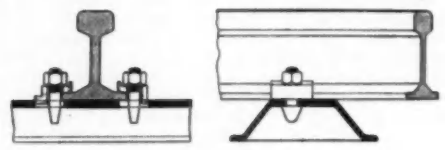


FIG. 3.—1881 *Type (German State Railways).*

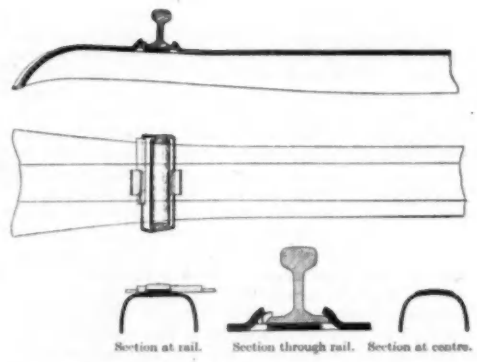


FIG. 4.—*Pressed-up Lug and Steel Key Type (Nizam's Guaranteed State Railways).*

SWAIN Sc.

80 lb. rails were riveted together in position on the sleepers, correct to gauge and tilt. The total weight of the sleeper complete was 184 lb. Between 1880 and 1888, 100,000 of these sleepers were manufactured at the Crewe works of the London and North-Western Railway Company, and laid down on various parts of that company's system. Of these sleepers, about 18 per cent. had been removed by 1894, of which some 8 per cent. only were fit for re-use, under slow traffic. By 1901 58 per cent. had been removed, and by 1908 86 per cent. The remainder were gradually removed, the last length having been taken out of the Weedon and Daventry section—a single line carrying light traffic—as recently as 1929. Two lengths of these sleepers, laid in the main line between Crewe and Preston, had a life of only 4½ years, whereas on other districts similar sleepers had a life of from 10 to 12 years.

The general defects which developed in this type of sleeper were corrosion, loose rivets, broken jaws, rapid deterioration of the sole plates, and the cracking of rail seats. The sleepers were not difficult to pack, but as the ends were open, difficulty was experienced in maintaining alignment.

In 1884 and 1886 steel sleepers, with tongues bent up from the plate to form the rail support, were laid down by the Great Northern Railway in the King's Cross district, and remained in running lines until 1900.

In 1887 a composite sleeper—known as Rafarel's patent—Fig. 8—was introduced, and a length of ¼ mile of this type of sleeper was laid on the railways of the Alexandra Docks, Newport. This was a rolled sleeper of great strength, 8ft. long by 9in. wide by 4½in. deep, with open ends. The chair jaws were cast with extended lugs passing through slotted holes in the sleeper plate, and these and the mild steel bearing plate were held together by means of special cotters. The total weight of the sleeper was 253 lb. It was expensive to manufacture, had too many loose parts, and though satisfactory for light traffic, could not be described as a general success.

The Great Western Railway laid down an experimental length of iron sleepers in their main line near Swan Village. These were composite sleepers, each cast iron chair being secured to the sleeper plate by four rivets. After a life in main line of only ten years they were removed in 1898, and two years later some 1900 of them were re-used in sidings, where they still remain.

The Great Eastern Railway used steel sleepers in running lines at Maldon. They were laid down in 1889, and transferred for use in sidings in 1904. Similar sleepers were laid down on the Edmonton and Cheshunt branch in 1892, and transferred to sidings in 1906–07.

The Great Central Railway laid down a length of steel sleepers of the trough type on the main Metropolitan and Great Central Joint Line near Rickmansworth in 1892. They were transferred to sidings in 1900 and finally scrapped in 1927, owing to extensive corrosion of the sleeper plates.

Trials of the Sandberg sleeper were also made on the Great Central Railway near Marylebone, but owing to rapid corrosion were removed and scrapped in 1927, after about eight years' life.

In 1921 the London and South-Western Railway laid down a trial length of about half a mile of Sandberg pattern sleepers, weighing 156½ lb. each, including sole plates. These sleepers are still in service on the Portsmouth main line and carry the heaviest engines running over the Southern Railway. Their condition to-day is on the whole such that many years' additional life may be expected from them.

During 1929 and 1930 a further 5000 tons—equivalent to approximately 30 miles of single track—of Sandberg sleepers of a somewhat deeper and heavier type—each weighs 168 lb. with sole plate—were laid down on the Southern Railway under varying conditions of track curvature and gradient.

The year 1928 saw a revival of the interest taken by British railway engineers in steel sleepers, and between the latter end of that year and the end of 1930 orders amounting to 29,582 tons were placed for steel sleepers of various types, to which detailed reference will be made later.

Manufacture and Specification of Material Used.—Steel for sleeper bars is accepted if of the best quality made by the open-hearth or Bessemer acid or basic processes, but if the last is specified the percentages of phosphorus and sulphur are limited to 0·07 and 0·05 respectively. It is a debatable point whether the inclusion in this specification of these limiting percentages is necessary in view of the stringent tensile and other tests to which the steel must conform. American engineers take the view that these tests control the phosphorus and sulphur maxima, but one cannot overlook the lack of homogeneity in steel made by the Bessemer basic process and the greater need for additional precautions before acceptance of steel so made.

The customary tests which it is proposed to include in the British Standard Specification are a tensile test giving a breaking strength of 28–32 tons per square inch, with a minimum elongation of 20 per cent. on 8in., together with the following bending test:—A strip 1½in. wide by 12in. long, cut longitudinally from the thicker portion of the plate, must be capable of being bent, either by pressure or by blows with a hammer, round a bar of a diameter equal to the thickness of the test piece. This bending test is considerably more rigid than that for structural steel, and is of particular importance for users—mainly colonial—of the pressed-up lug type of sleeper for flat-bottomed rails.

Sleeper bars may be pressed into sleeper form, either in one operation at rolling heat—continental practice—or in two operations. If the latter process, that usual in this country, be adopted, the sleeper bars must be reheated and delivered to the press at a regular temperature.

The punching-up of lugs for flat-bottomed rails necessitates special care to ensure that correct gauge is given on the finished sleeper. Should such punching be performed in two operations, the sleeper must be allowed to get perfectly cold before reheating for the punching of the second pair. Failure of insistence on these details inevitably results in gauge variations.

The gauge tolerances allowed by engineers show considerable variation. The general practice is that, although tightness of gauge is disallowed, slackness up to ¼in. is permitted. On the Great Western Railway a tolerance of $\pm \frac{3}{64}$in. is allowed. With the composite type of sleeper—chairs cast on to sleeper plates—in most general use by that company, no difficulty is experienced by the manufacturers in keeping well within these tolerance limits.

Inspection and Gauging.—After a steel sleeper has once been completely manufactured, opportunities for adjustment of gauge, except possibly with certain special types, cease, on which account particular care must be taken that the system of inspection and gauging during manufacture is a thorough one.

Sleeper specifications include provision for the supply by the manufacturer of complete sets of metal templates, gauges of the punches, and dies to be used for forming the holes or lugs. In the case of sleepers for flat-bottomed rails, tilt gauges must be provided to ensure that the correct

tilt is given to the sleeper plate under the rail seat. With the chaired type, similar gauges are used to check the tilt which is provided in the chair seat.

To ensure the requisite degree of gauge accuracy, the whole of the sleepers under a contract are laid out and each one is gauged and checked. As an additional safeguard, short lengths of track of about ten sleepers are from time to time laid out complete, ready for service, and tested with a rail track gauge to ensure that there is no "wind" on the sleepers, such as could not be detected by the gauging of individual sleepers.

That such thorough inspection is necessary is beyond question, and is fully appreciated by manufacturers. So far as the author's experience goes, the accuracy of gauge of the composite chaired type of sleeper is entirely satisfactory.

Dipping of Sleepers.—A very debatable point is that of the value of dipping sleepers in some preservative mixture before they are taken into service. The preservation by painting of structural steel in bridges, &c., is rightly stressed, but from actual, though short, experience of steel sleepers in track it is evident that all preservative coatings, at any rate on the upper surfaces, are very soon worn off by "lengthmen" and others who walk the track with less business than they.

Personally, the author feels that steel sleepers should be protected by a suitable rust-resisting coating, and here, again, he is faced with divergence in practice, more as to the means of application than as to the composition of the preservative. To be effective the coating should be smooth, tenacious, sufficiently hard not to soften on exposure to the direct rays of the sun producing a temperature of 140 deg. Fah., but not so brittle when cold as to chip when tapped with the edge of a knife.

Table I. illustrates the divergences in practice.

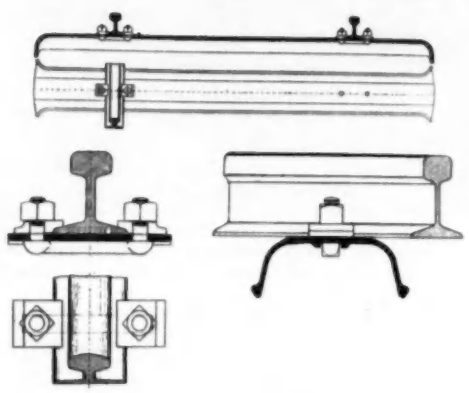


FIG. 5.—*Stirrup Bolt Type (Mexican Southern Railway).*

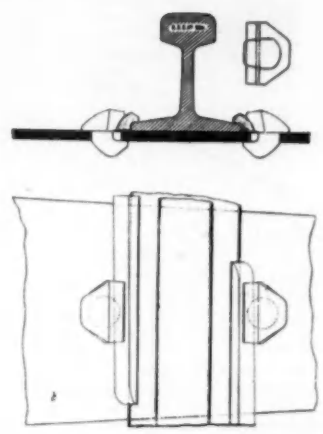


FIG. 6.—*Round-hole Loose-jaw Type (Indian State Railways).*

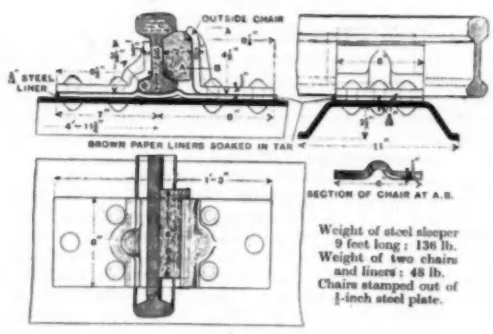

OUTSIDE CHAIR
STEEL LINER
BROWN PAPER LINERS SOAKED IN TAR
SECTION OF CHAIR AT A.B.
Weight of steel sleeper 9 feet long: 136 lb.
Weight of two chairs and liners: 48 lb.
Chairs stamped out of ½-inch steel plate.

FIG. 7.—*Webb's Pattern.*

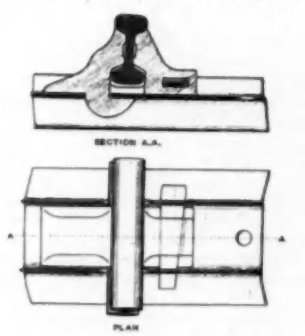


FIG. 8.—*Rafard's Patent Sleeper* (1887).

"THE ENGINEER" SWAIN SC.

Economic Aspects of Manufacture.—The manufacture of steel sleepers is highly competitive. In the case of British railways the competition is with timber sleepers, and in that of railways overseas with steel sleepers of continental manufacture. For economic success, accurate mass production is essential, and this means suitable designs of the simplest practical form. The fullest use must be made of mechanical means for conveyance and handling, both for manufacturing processes and for inspection.

Comparison of Continental and British Practices.—The main difference between continental and British methods of manufacture of steel sleepers lies in the method of pressing. In Belgium and Germany sleepers are pressed direct from the ingot into permanent trough form, shaped as required at the rail seat. Our home practice is to roll from the ingot flat plates of appropriate width, from which sleepers are subsequently pressed. It will be apparent that a manufacturing process capable of producing an acceptable steel sleeper with the minimum of handling is the only one that will place the metal sleeper on an economical equality with that of timber. The punching up of lugs for the reception of flat-bottomed rails involves the cooling and reheating of sleeper plates to preserve the subsequent track gauge. Manufacturers are fully alive to the possibilities of the elimination of all such intermediate steps, whether for flat-bottomed or bull-head track.

Standardisation.—Attention has been for some time focussed on the unnecessary multiplication of types of steel sleepers, which, though similar in essentials, vary considerably in details of no great importance in themselves. A committee of the British Engineering Standards Association has thoroughly investigated the matter and has found it possible to standardise a number of types of sleeper plates suitable for various gauges and types of rail, appreciably fewer than those at present called for. The consequent reduction in roll changes in the mills should be of benefit both to the manufacturer and the purchaser.

Standardisation of supports to suit both bull-head and flat-bottomed rails presents greater difficulties than the standardisation of sleeper plates, but is perhaps of less importance. There is no doubt that, with some latitude, a helpful measure of standardisation will be reached with separate standards to suit the two types of rail.

TABLE I.—*Coating of Steel Sleepers.*

Process	De Wendel.	Thyssen.	Ougree.
Sleeper temperature before dipping	180° to 240° Cent. (356° to 464° Fah.)	150° to 200° Cent. (302° to 392° Fah.) No fixed maximum before dipping	62° to 70° Cent. (143·6° to 158° Fah.)
Temperature of bath ..	65° to 70° Cent. (140° to 158° Fah.)	Approx. 200° Cent. (Approx. 392° Fah.) No fixed maximum or minimum	Ditto
Maximum time of immersion	10 sec.	Approx. 5 min. (sleepers pass through bath on chains)	50 sec.
Special remarks regarding process used for heating bath	The bath is primarily heated by hot bars, the temperature being subsequently maintained by the hot sleepers passing through	The bath is heated by means of coiled tubes through which steam flows, raising the temperature to about 200° Cent. 392° Fah.)	The sleepers remain in the furnace for the same time as in the bath, which attains the temperature of the sleepers 20 min. after the first sleeper has been dipped. The bath is not heated owing to the inflammable nature of the dipping composition used, and the absolute temperature must not exceed 70° Cent. Furnace is of the crude oil type, and the sleepers are carried through on an endless chain

With considerable knowledge of the difficulty of the removal of mill scale from structural steel, the author has grave doubts as to the efficacy of any preservative coating applied almost immediately after rolling and pressing. He inclines to the view that if, as time alone will show, corrosion determines the life of a steel sleeper, the remedy will be rather in the direction of an admixture to the steel of a non-ferrous metal—for example, copper—than in the external application of preservatives. The economic value of such an admixture must, however, be the ruling factor.

General.—The experience gained by manufacturers in the rolling of sleeper plates for use in the Colonies and the knowledge gained by them from study of continental practice, removed all anticipated difficulties in the design of the sleeper proper.

The main difficulty was that experienced by continental users in the elimination of movement between the rail, or the bearing plate under the rail, and the sleeper. Should such movement occur — and it is a real trouble — the hammering action of the rail flange, or of its bearing plate, on the sleeper, accentuated by the presence of water and grit between the two surfaces, causes rapid corrosion and deterioration by oxidisation of that part of the sleeper plate exposed to such attrition, necessitating the removal from service of the sleepers at dates considerably in advance of their normal life period.

Such a condition of affairs is particularly prevalent in atmospheres charged with salt—in the vicinity of the sea—and with active chemical reagents in industrial areas. For instance, in the Ruhr Valley in Germany, owing to the numerous factories and chemical works, steel sleepers cannot be economically used, and are being replaced by timber. The author has personally seen the removal of steel sleepers in this district after only six years' service.

The continental users of flat-bottomed rails incline to the use of steel bearing plates with all classes of sleepers, and whilst the rigid attachment of these to steel sleepers presents comparatively little difficulty, the problem of providing a similar attachment for the rail chair necessary for a bull-head rail presents far greater difficulties.

With timber sleepers, such chairs have invariably been of cast iron with a considerable area of base to distribute the load, independently cast, and subsequently attached to the sleeper by bolts or coach screws. A similar attachment to steel sleepers, by the use of separate fastenings, can only be made by bolts, rivets, or by some form of clip. Riveting of cast chairs can, without hesitation, be ruled out as being uneconomical, if not impracticable. Bolting is open to the great practical objection of the difficulty in maintaining close contact between the chair and the sleeper. Clipping introduces an undesirable number of members requiring constant maintenance. The contact difficulty appears to have been successfully overcome by one manufacturer by actually casting on the chair to the sleeper, and by others by welding to the sleeper a rolled steel chair. In another type the chair jaw forms an integral part of the steel sleeper, the rolled bearing plate, on which the rail beds, being held in position by driving, to the correct degree of tightness, a special wooden rail key.

For the reasons previously given, the author would hesitate to recommend a trial in actual service of any type of steel sleeper unless the attachment of the chair was a permanently rigid one. An attachment of metal to metal requiring constant adjustment would render maintenance costs prohibitive.

Various types of steel sleeper with fastenings suitable for flat-bottomed rails have already been illustrated, and it is not proposed to give extended descriptions of these now well-known and proved types. Description will be mainly confined to types suitable for bull-head rails.

(To be continued.)

SIXTY YEARS AGO.

STEEL tires for railway wheels formed a subject of considerable interest sixty years ago. In our issue of December 22nd, 1871, we summarised the results of an investigation into the subject which the Association of Master Mechanics in the United States had recently made. Twenty-six railways had replied to the questions addressed to them by the Association. Up to the middle of 1871, it seems, Krupp's agents had sold some 19,500 steel tires in the United States. The sales of William Butcher's tires amounted to about 11,500. Of Vicker's tires, just short of 11,000 had been sold, and of Firth's something over 6000. In addition, French, Bessemer, Taylor, Lowmoor, and Washburn and Campbell tires were in use. The replies received from the railways related to the performance of 653 sets of tires. They showed a very great variation in the performance. One set of Krupp tires was reported to have run 123,347 miles before it showed a wear of $\frac{1}{8}$ in. That figure was contrasted with the performance of a set of Vicker's tires which ran only 1081 miles before it showed $\frac{1}{8}$ in. wear. Yet on the average Vicker's tires gave the highest performance with just on 18,000 miles for the specified amount of wear, Krupp tires coming fourth with 15,000 miles and Lowmoor tires last with 7200 miles. The only conclusion to which the Association could come was that after making every allowance the quality of steel tires was very variable, and that apparently the more steely the tires were the more uncertain was the quality. Concerning the breaking of tires, it was reported that within a certain unspecified period one Krupp, eleven Vickers, one Firth, five Butcher, and five unnamed tires had broken. Great difference of opinion seemed to prevail concerning the best system of fixing the tires to the cast iron centres. Twelve superintendents used shrinkage alone, seven employed shrinkage and set screws, three used wooden blocks on Grigg's system, and one left the tire with a shoulder on the outside and rolled or hammered down the inside lip. An even greater difference of opinion was manifested as regarded the shrinkage allowance. It varied from $\frac{1}{16}$in. on a 4ft. tire to $\frac{1}{22}$in. on a 5ft. tire. It was elicited that most of the tires which broke in service failed because they had been shrunk on too tightly.

COILING a band saw often presents difficulties to the novice. The trick is not, however, difficult, once its principles are understood. The proper way is, according to the *Edgar Allen News*, to employ the threefold coil, which is the only safe way to coil a band saw without risk of distorting it, or of damage to the user. Place the saw in a single loop as it goes on the machine, standing on the floor with the foot holding down the lower part of it. Then grasp the upper part with the two hands about 2ft. apart and level with the face. Give the saw three distinct twists. Then stoop, lowering the saw to the floor, when it will fall naturally into the three-coil fold.

Shanghai Waterworks Extensions.

By H. STRINGER, B.A. A.M. Inst. C.E., M.I. Mech. E., Deputy Engineer-in-Chief.

No. I.

THE International Settlement of Shanghai is a city of about 1,000,000 people, and its water supply is taken from the Huangpu River, on which it is situated. This water has an average turbidity of 223, and an average bacterial content of 80,635 at 20 deg. Cent. and 50,072 at 37 deg. Cent. Shanghai, therefore, is in the unenviable position of having one of the most turbid and probably the most polluted sources of water supply in the world. The purification of such a source of supply consequently presents a many-sided problem, quite apart from the abnormal growth in water demand.

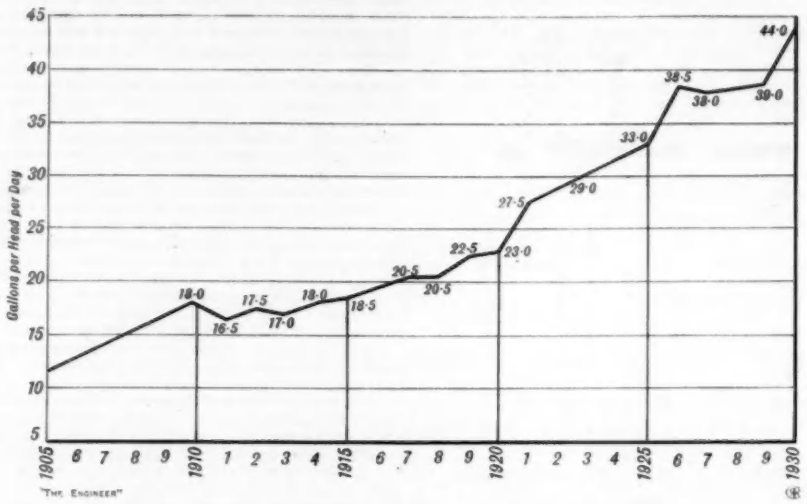


FIG. 1—CURVE SHOWING CONSUMPTION PER HEAD PER DAY

DEMAND.

As shown by the curve in Fig. 1, the year 1920 was remarkable for a very much increased upward tendency in the per capita consumption—for all purposes—of water in the Settlement. In 1905 the consumption per head per day was only about 11¼ gallons. It then gradually rose till in 1920 it was 23·0 gallons.

FIG. 2—PITCHING OF OUTSHORE INTAKE CYLINDER

but thereafter there was an astonishing increase. By 1920 it had become clear that the old methods of draw-and-fill, and settlement by gravitation only, could not provide water of a quality which the slow sand filter beds available could sufficiently purify at the rates demanded of them. As a consequence, coagulation was adopted, imported aluminium sulphate with a 17 per cent. aluminium oxide content being used for this purpose. The high rate of increase in water demand persisted, as is shown by the curve, and in 1924, it became apparent that increased capacity, both in settlement and filtration, was required.

An extensive reconstruction programme was consequently put in hand in 1925, after small-scale experiments had been made in methods of continuous settlement and rapid filtration. As an introduction to a description of the extensions which have taken place in the period 1925 to 1930, it should be stated that water is pumped from the river to settling tanks, then pumped to rapid filters, and finally pumped to the town mains. The three stages of pumping are known as primary, secondary, and main. The slow sand beds are practically all fed by gravitation from the settling tanks.

INTAKES.

Increased settlement capacity, of course, implies the provision of more river water, and in order to provide it an outshore intake was constructed in 1925. This is shown under construction in Figs. 2 and 3, the cylinder being of steel and 10ft. in diameter, and the connecting steel flanged pipe, 60in. in diameter by 170ft. long. The cylinder is 45ft. long, and is sunk 18ft. below the river bed, that depth being required owing to a future dredging scheme which the Conservancy Board has in view. The intake trench was sunk by dredging a foun lation before pitching, and then excavating through doors in a diaphragm fixed 7ft. above the cutting edge. On completion of the excavation the space below the diaphragm was filled with concrete. The connecting, 60in. diameter pipe, was assembled on shore, slung by a floating crane and dropped through guides into a previously prepared dredged channel, the bolting up being done by divers. The capacity of this intake with 1ft. loss of head is about 3,000,000 gallons per hour.

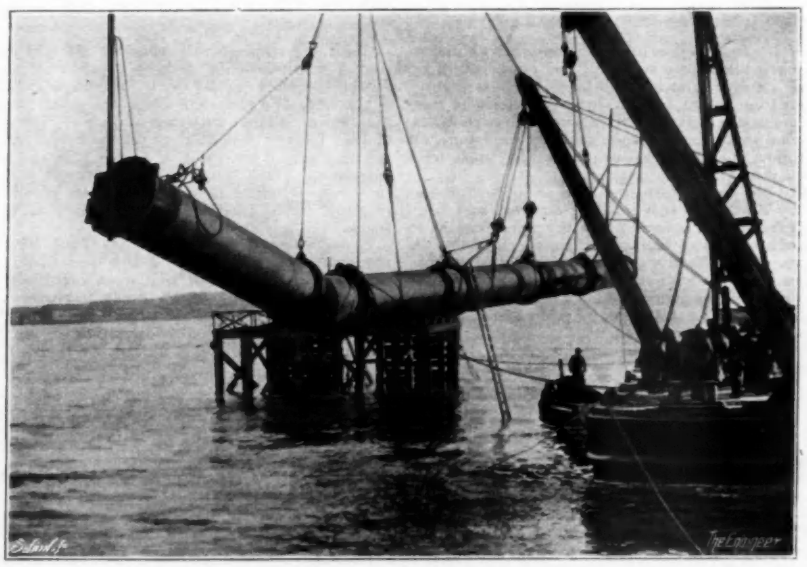


FIG. 3—60IN. OUTSHORE INTAKE CONNECTING PIPE

In 1929 additional settlement was required and the construction of a further intake was put in hand. Two factors were responsible for a change in design. The first was the possibility of a ship getting out of control and colliding with and damaging an intake of the type just described. The second was limitation of settlement in the pump houses which occurred owing to the dredging of the deep channel required for the installation of the connecting pipe mentioned above.

For these reasons an inshore type of intake was adopted with a dredged channel, 20ft. wide, with heavy 8in. timber birdsmouth sheet piling to its sides for a length of 45ft. towards deep water. Bottom levels were fixed to give 10ft. of water at lowest tides. The new intake is fitted with two motor-driven vertical revolving screens of ⅜in. square mesh, each capable of passing 2,000,000 gallons of water per hour at a velocity of 2ft. per second. These screens, which are 6ft. wide, are housed in two rectangular reinforced concrete twin wells, each 7ft. 2in. by 11ft. long, which are connected by two 42in. pipes to the pump wells. Considerable constructional difficulty was encountered at this point, owing to damage to two of the sheet steel piles which formed the cofferdam. With under-water pressures of about 18ft., four serious foundation "blows," as would have been expected with mud with a sand content of 72 per cent., occurred. This difficulty was got over by a sand bag dam, laid on tarpaulins, outside the sheeting, the bottom width of this dam being 10ft. Figs. 4 and 5 show the general appearance of the new intake and the revolving screens. The total intake capacity of the plant is now 8½ million gallons per hour, and it will shortly be increased by a further million and a-half on the construction of a further inshore intake on the lines just described above.

CONTINUOUS SETTLEMENT TANKS.

The success of this method of treatment depends, of course, on adequate mixing of the alum dose, accurate regulation of the water velocities in the tank, and correct slopes to the mud pockets which will ensure flow of the deposited mud through the pipes connected to the mud pump. The general arrangement is shown in Figs. 8 and 9, page 652, the first of which shows the continuous settling tank and the second the hopper pockets for mud collection. The velocities adopted through the tank are as below :—

Mixing chamber	6·36in. per second.	Mixing time of 14 min. with six channels
Tank	1·00in. per second,	giving a contact period of 80 min.

To obtain this contact period the tank is baffled by a central wall.

FACTORS INFLUENCING DESIGN.

As continuous settlement would give three times the quantity of water given by the old method of draw-and-fill, with a maximum period of six hours quiescence, conversion of the old tanks was obviously indicated. That could only be carried out piecemeal during the winter when demand was low, but a more ambitious programme was prohibited by the fact that periods of quiescence had fallen as low as half an hour during maximum demand in the summer months.

With the adoption of continuous settlement, the problem of continuous mud removal was inevitably limited, as a deposition of mud at three times the rate experienced with the old method of working would have tied up the tanks at too frequent intervals for cleansing by hydraulic sluicing; besides, that method closed down each of the tanks, when worked under draw-and-fill conditions, for a fortnight to three weeks, depending on the size of the tank, in the spring and autumn of every year. Fig. 10, page 652, shows a tank being cleaned by this method.

One of the factors influencing design of the first mud-removal system was the impossibility of gravity sluicing to the river with the existing tanks. These tanks were 16ft. deep, and, even if raised to the minimum depth of 10ft. required for continuous settlement, certain stages of the tide would have rendered gravity sluicing inoperative. As a consequence, it was necessary to adopt mud pumps. A second factor in design was the physical properties of the deposited mud. With a mud with a 40 per cent. dry solid content the angle of repose ranges between 10 deg. and 15 deg., while, with a 75 per cent. dry mud content, the angle of repose varies from 24 deg. to 19 deg., with increasing pressure. Experiments with regard to angle of repose were carried out with varying water pressures, such as would obtain under working conditions, and, as a

result of them, a slope of 20 deg. was given to the mud-collecting pockets. In practice, however, these slopes proved insufficient, and the mud has to be assisted down the slopes by hand-operated shoes.

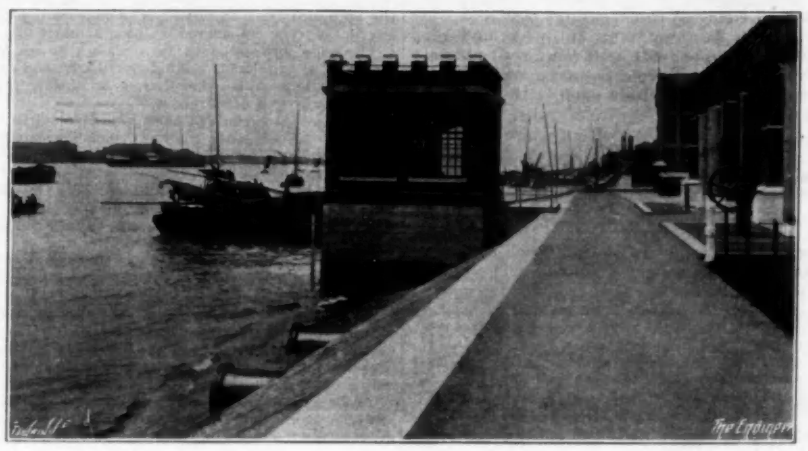


FIG. 4—GENERAL VIEW OF NEW INSHORE INTAKE

The following are the general dimensions:—

Tank	256ft. by 150ft. by 16ft. deep
Main baffle wall	199ft.
Six baffles in mixing chamber	10ft. centres
Mud pockets ..	36ft. square with slopes to central valve of 20 deg. These slopes were formed of 4 to 1 lime and mud filling with a 4in. thick skin of concrete on top
Piping	Four mud-pump collecting pipes of 9in. diameter connecting with a 9in. manifold housed in a 9ft. wide culvert to allow of rodding the pipes through hatch-boxes.*

* These have never been required in practice.

The work was carried out in the case of No. 2 tank—see Fig. 7—in 1926, and a similar tank, known as No. 1 tank, was converted to the same use in 1929. The coversion of this latter tank was effected in a similar manner, except that the mud pockets were omitted on the outlet side of the baffle wall, as it was found that 95 per cent. of the mud was deposited in the first half of the tank. This change effected a saving of fourteen sets of valve gear with the necessary collecting pipes. It was also found in practice that the mixing channels silted up until an approximate channel area of 60 square feet was formed with a velocity of 12in. per second. The depth of mixing channel was thus reduced to 6ft. below working level.

These two tanks, worked at the above rates, each give 1,500,000 gallons per hour of settled water with a turbidity of 50 at outlet. The effluent from both these tanks is passed through a third tank, in which an extra contact period is obtained. The final turbidity is, by this means, decreased to 30 on delivery to the filter beds. The velocity in this tank is 0·5in. per second, giving an additional contact period of 100 minutes.

This tank, which is 247ft. by 200ft. wide and 16ft. deep, was, in 1926, provided with a central wall 247ft. long, dividing the tank into two, so that one half of the tank could be put off for cleaning. This wall was constructed in reinforced concrete and is "T" shaped in cross section, with a base width of 14ft. by 1ft. 7in. thick. The wall thickness is 2ft. at the base and 8in. at the top, where a platform 3ft. wide is provided.

Further continuous settlement capacity was also provided in 1927 as the result of the necessity to repair the gravity dam which formed one of the walls of the settling tanks, known as 5 and 6—see Fig. 7. As these dams developed serious leakage at levels of 14ft. and had a working level of 18ft., it was decided to eliminate secondary pumping from settling tanks to filter beds by raising the dam level to admit of a working level of 22ft., thus providing a gravity feed from the settling tanks to the slow sand filter beds, which have a maximum demand of 1,500,000 gallons per hour. The dam was light in section, with slopes of 1 to 1·75, and a 10ft. top width, but it was stable enough for the conditions required.

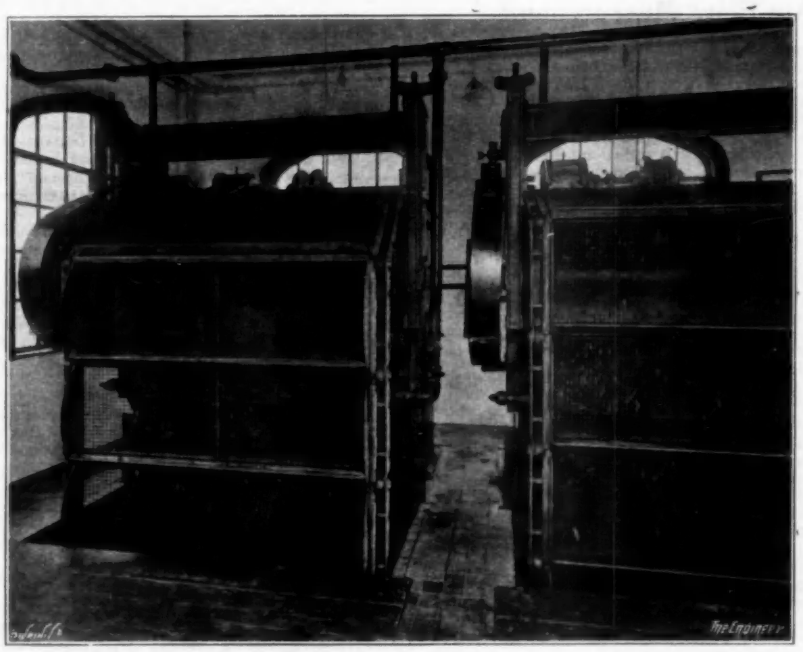


FIG. 5—MOTOR-DRIVEN REVOLVING SCREENS FOR INSHORE INTAKE

It was therefore decided to try and eliminate leakage by removing the pitched face and replacing it by a skin of reinforced concrete 6in. thick. As the clay of the dam was found to be in excellent condition, this skin was designed for waterproofing purposes only, its strength in shear being only equivalent to a plaster of mud 3ft. thick up the face of the dam. As an additional safeguard to counteract any danger of upward pressure, the toe of the dam was sheeted with 15ft. by 4in. birdsmouth sheet piling. Expansion joints in the 6in. skin, which occur at intervals of 50ft., were made in sheet zinc.

Further, in order to check leakage and to improve conditions in the rather weaker sections at the base of this dam, it was decided to add a plaster of mud rammed in 6in. layers, the top level of this being 10ft. above the tank bottom and with a slope of 2 to 1. Since that was done leakage has progressively decreased and moved downwards and is now almost negligible. The dam has been in continuous use since the spring of 1929 and has resulted in an annual saving in secondary pumping to the value of Tls. 15,558—£1321 or G$6455.

In other essentials the principles of design are the same in this tank as in Nos. 1 and 2 tanks, but in this case a different method of mud removal was adopted owing to the higher working level of the tanks and the possibility of frequent gravity sluicing into the river. The suspended matter settled there into a series of twenty-three channels, each 103ft. long, placed at right angles to the direction of flow. These channels, which are at 12ft. centres, are triangular in section, 5ft. 6in. deep, with 45 deg. slopes. The bottom width of the channel is 9in., and it is pierced at 3ft. intervals with 1in. diameter holes, through which the mud flows to a 6in. by 6in. collecting channel underneath. These channels have a fall of 6in. and are closed by 6in. valves at their junction with a concrete manifold 1ft. wide by 1ft. deep with a fall of 1 in 75. This manifold conveys the mud to two 20in. pipes which go through the dam to the river 6ft. above the tank bottom. In order to keep the mud in motion when sluicing, each channel is provided with a set of hand-worked scrapers. This method of mud removal, which was adopted as a result of lengthy experiments, has not as yet proved an entire success, and an air lift pump fixed to a float has been used to supplement the gravity sluicing. This pump delivers into triangular wooden channels fixed to the ridges of the existing mud removal channels. Fig. 11, page 652, shows the general appearance of these tanks, while in Fig. 6 the compressed air pump is seen at work.

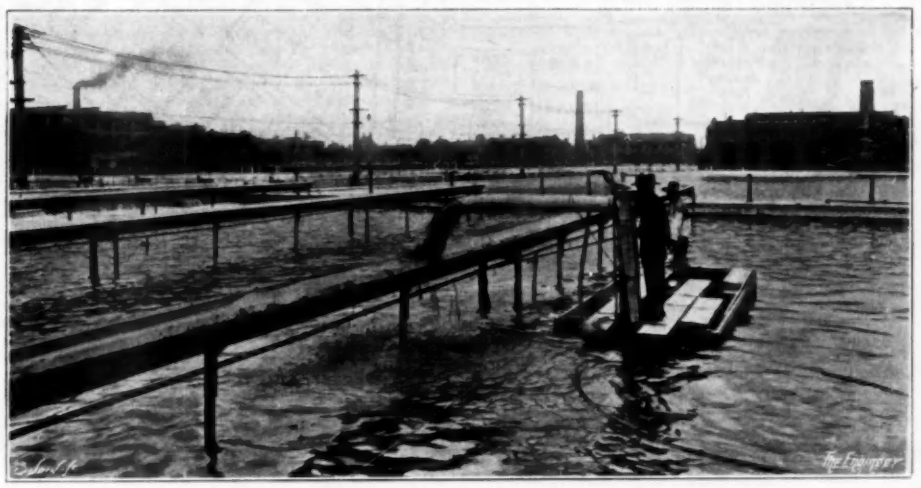


FIG. 6—CONTINUOUS SETTLING TANK—COMPRESSED AIR PUMP AT WORK

General Dimensions.

No. 5 tank	350ft. by 280ft. by 22ft. 6in. deep No mixing chamber as water falls over a weir. Length of baffle wall, 280ft. Number of mud-collecting channels, 23
No. 6 tank	320ft. by 280ft. by 22ft. 6in. deep Future baffle wall extension of above, 190ft. Future number of channels, 13 Velocity at inlet, 0·75in. per sec. Velocity at outlet, 0·16in. per sec. Settlement period, 6¼ hours Capacity, 1,500,000 gallons per hour

The foregoing completes the description of the major works relating to settlement, the capacity for which is now 4,000,000 gallons per hour, and the future capacity 6,500,000, without further alterations.

Costs.

	Working capital.	Total.
	Tls.	Tls.
Estimated cost per million gallons of discontinuous mud removal in 1927	0·408* .. (G$0·169) .. (8¼d.)	0·545 .. (G$0·226) .. (11d.)	0·953 .. (G$0·395) .. (1s. 7¼d.)
Estimated cost per million gallons of continuous mud removal in 1927 in No. 2 tank	0·166 .. (G$0·069) .. (3¼d.)	0·590 .. (G$0·245) .. (1s.)	0·756 .. (G$0·314) .. (1s. 3¼d.)

* This figure is the actual cost of removing mud by hydraulic sluicing after the settlement of 5866 million gallons in Nos. 5 and 6 tanks, using steam pumps in 1927. Electric pumps would have reduced this to Tls. 0·251. The time taken was twenty-one days for No. 5 tank and twenty-eight days for No. 6 tank.

The actual working cost of continuous mud removal in 1929 was Tls. 0·136 per million gallons. Mud disposal also involves the Company in additional expense, as payment has to be made for dredging the material pumped back into the river. This added Tls. 0·417 per million gallons to the settlement costs in 1929 at 41·2 per cent. load factor approximately.

Total settlement cost per million :

1930..	Tls. 6·45 (11s. or G$2·67)
1929..	Tls. 5·65 (9s. 7d. or G$2·34)

FILTRATION.

Apart from other considerations, the notable increase in land values, and the dilatory methods of conducting land deals in the Chinese manner, practically compelled the adoption of rapid filtration. In this process the usual rate of working filters is 100 gallons per square foot per hour as against a maximum of five, and an average of about two, in slow sand beds. Thus, though the capital cost in 1923 of slow sand filters was only Tls. 1·85 per square foot, as against the cost of Tls. 26·70 for the rapid filters constructed in 1925, the capital cost for equal capacity of slow sand beds would have been at least Tls. 100, quite apart from cost of land if it could have been obtained in time.

The operation costs of rapid sand filters are, however, higher than these for slow sand beds—Tls. 3·59 per million gallons, as against Tls. 2·58 in 1929. The average demand in 1929 on rapid filters was 411·6 millions, *i.e.*, 57·2 per cent. load factor, giving an extra operating cost of approximately Tls. 5000 per annum, which adds, at 7 per cent., a further capital expenditure of Tls. 71,500 to rapid filtration, thus bringing the cost per square foot up to Tls. 33·25.

RAPID FILTERS.

Two batteries of eight rapid filters have been constructed since 1925. Both are of the same capacity —1 million gallons per hour. Generally, the designs are similar, but in the battery constructed in 1925 experience showed that the expectation of algal growth on these filters would not be realised, and that they need not be covered. This alteration admitted of raising the reservoir capacity beneath the filters to 750,000 gallons, as against 500,000 gallons in the first battery, which gives a longer contact period for chlorination with consequent improvement in the bacterial quality of the effluent. Further, some simplification in piping and saving in valves resulted in the adoption of a Larner-Johnson two-way valve instead of individual valves for influent sewer, wash water, and effluent pipes. Again, as a result of experience of foundation settlement in the first battery, the eight new filters were designed as four independent units of two filters each, while the pipe gallery and operating floors between each set of four filters are entirely independent units. A further improvement was the substitution of steel and corrugated iron for concrete in the roof of the operating floor.

Lastly, in order to admit of isolation of each set of rapid filters, the effluent channels were built in duplicate. Opportunity was also taken of utilising the column system necessary to support the central wash and sewer pipes in the pipe gallery to support the operating floor above.

The following is a dimensional description of the work.

The whole building in plan consists of three independent units constructed on separate foundations ; two reinforced concrete reservoirs on east and west sides, each 159ft. 2in. long, 40ft. 8in. wide, and 12ft. high, inside dimensions, with four reinforced concrete filters on top of each reservoir, poured in two separate units, consisting of two filters each. All filters are 40ft. by 41ft. 6in. centre to centre of walls, by 8ft. 3in. high, not covered on top. In the centre is a reinforced concrete clear water chlorine contact chamber, 159ft. 2in. long, 26ft. wide and 8ft. 3in. high, with a reinforced concrete pipe gallery above, on top of which is the operating floor, 159ft. 2in. by 27ft. by 9ft. 10in. high to the bottom chord of the roof truss. The operating floor walls are of 10in. brick in cement mortar, with buttresses at 32ft. centres. These walls are laid on the top of the reinforced concrete filter walls on the east and west sides, and on top of the pipe gallery walls on the south and north sides.

(To be continued.)

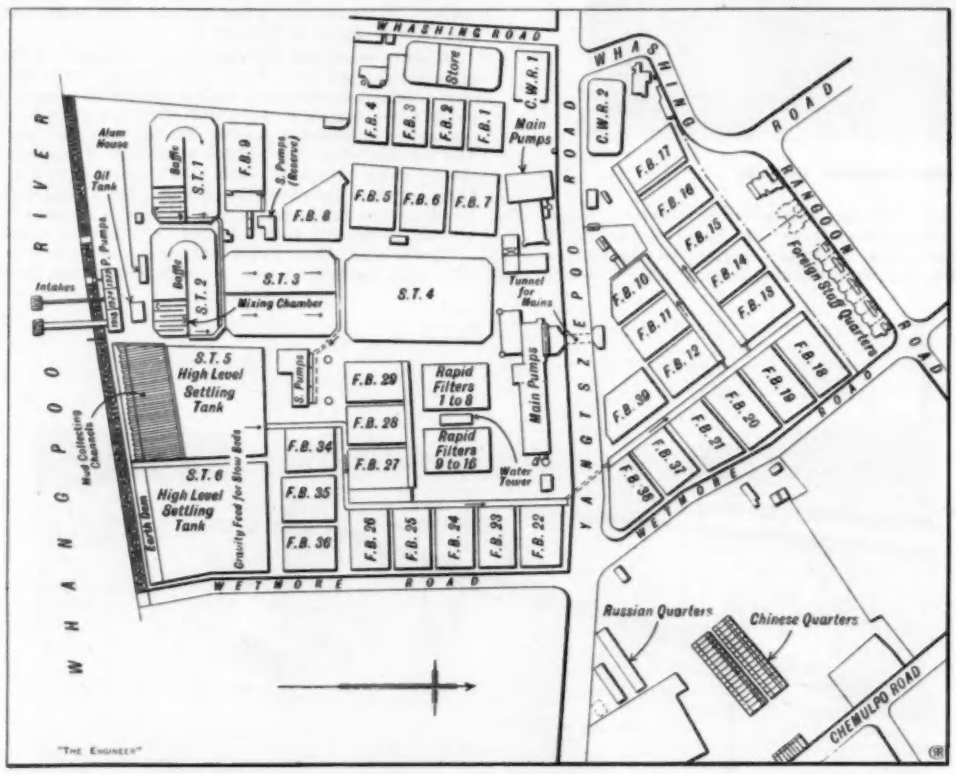


FIG. 7—GENERAL PLAN OF WATERWORKS

Air Flow Measurement.

EARLY in 1929 representations were made to the Heat Engine Trials Standing Committee that, in connection with the Air Compressor Code contained in the Report of the Committee published in 1927, the question of air flow measurement should be further investigated with a view to defining a standard method of measurement of air flow by means of nozzles, and a Sub-Committee on Air Flow Measurement was appointed.

Having ascertained that manufacturers of air compressor plant would welcome the adoption of a rounded nozzle, with a parallel portion of throat, as a standard for use in this country, the Sub-Committee examined the results of tests made at its direction on different types of nozzle. It also kept in touch with investigations made during the past few years in Germany, France, and America, and noted the similarity in the standards adopted, or about to be adopted, on the Continent of Europe regarding the use of nozzles for the measurement of steam and air flows.

In the result it has issued a report from which the following passages are taken.

1. Air compressors, blowers and fans may be tested by discharging the air to the atmosphere through a nozzle or by passing the air through a nozzle in a pipe line. Exhausters may also be similarly tested with the nozzle on the intake side.

The nozzle to be used is the I.G. (Interessen Gesellschaft) type nozzle—see Figure—and is to be made of bronze, cast and machined truly parallel in the throat. The thickness of the metal is to be sufficient to prevent deformation during use either from working pressures or otherwise. The diameter of a nozzle is that of its throat or downstream side, (d_2) and all other dimensions are fixed in terms of this diameter.

2. The drop in pressure (h) between the upstream and downstream sides of the nozzle is to be measured by a double leg manometer. In order to obtain m_2 the difference in pressure between the downstream side of the nozzle and the barometer is to be measured by a second manometer ; a similar measurement is to be made on the upstream side of the nozzle. The pressure pipes to the manometers are to be connected to the top or sides of the nozzle, so as to prevent moisture collecting in these pipes.

The nozzle is to be attached to the pipe system leading from the compressor, the length of straight pipe of uniform bore upstream of the nozzle is to be not less than 20 nozzle diameters, and its diameter is to be between 2·25 and 2·50 nozzle diameters. The nozzle should be designed to suit the standard sizes of pipes. The approach pipe and the nozzle are to be considered as integral parts of each other.

The pipe system is to be drained, so as to prevent moisture accumulating behind the nozzle, and may be laid at any angle provided that there is no obstruction to interfere with the free flow from it.

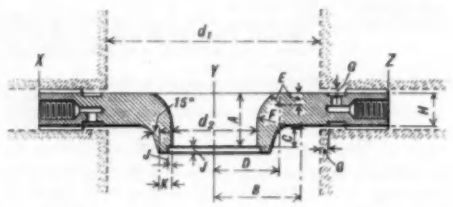
The internal surface of the pipe attached to the nozzle need not be smoother than is usual in customary commercial finish, and riveted pipes may be used for the larger sizes.

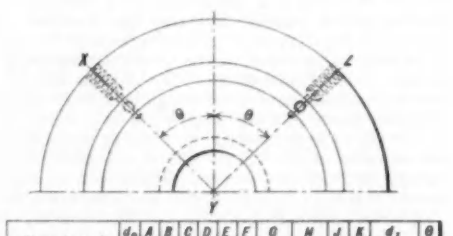
The nozzle is to be shielded by allowing the discharge to take place into the open air through a pipe of the same diameter as the upstream pipe and in length not less than 10 nozzle diameters.

In all cases the temperature is to be measured on the downstream side of the nozzle at a distance of 4 nozzle diameters.

The thermometer pocket is to be well immersed to ensure that the temperature of the air is taken, not that of the pipe, but in large pipes for nozzles exceeding 8in. in diameter the immersion need not exceed one-half the nozzle diameter.

The air from the compressor is to be delivered into a receiver, from which it is to pass through a flow-control valve to the measuring nozzle. Passage through the control valve will expand the air, and it will pass through the nozzle at a pressure not greatly in excess of atmospheric pressure. By this means the pulsations of reciprocating compressors will, generally, be eliminated. In cases in which these flow pulsations are not eliminated, other means, as described in the Heat Engine Trials Report, page 278, should be adopted. In order to eliminate the eddies





Dimensions of Standard Nozzle in Terms of d_2	d_2	A	B	C	D	E	F	G	H	J	K	d_1	θ
	1	0·605	0·83	0·30	0·75	0·20	0·33	0·05 Minimum	0·35 Maximum	0·033	0·063	2·25 to 2·50	10°–30°

"THE ENGINEER"

I.G.-TYPE NOZZLE

caused by the flow-control valve, a honeycomb grid is to be fixed in the pipe upstream of the nozzle.

3. For the purpose of calculating the flow of air the following formula is to be used :—

$$Q = 0{\cdot}1148\, M\, \Omega\, \delta\, \Delta\, d_2^2\, \sqrt{h}\, \sqrt{(m_2/T)}\ \text{lb./sec.}$$

The equivalent discharge in cubic feet per minute of air at standard temperature (60 deg. Fah.) and pressure (30in. Hg.)

$$= 60\, Q/0{\cdot}0764 = 785\, Q,$$

while the corresponding discharge at any other temperature and pressure may be obtained therefrom by the usual dry gas formula.

For commercial purposes air is to be treated as a dry gas, and no calculations need involve humidity. It is recommended that a table of the values of $\sqrt{(m_2/T)}$ be prepared over the usual working ranges of temperature and barometric pressure.

For all nozzles used under the specified conditions the working value of the product of the three coefficients $M\,\Omega\,\delta$ in the flow equation is to be 0·995.

Nozzles of all diameters greater than 0·5in. are to be used over the range from $h = 0{\cdot}4$ to $h = 40$ with an overload of 25 per cent., provided that the flow is greater than 10 cubic feet per minute. The value 0·995 is subject to a tolerance of $\pm$ 1·5 per cent.

To find an approximate value of d_2 for a working value of $h = 40$in. of water for a given volume,

$$d_2 = \tfrac{1}{12} \times \sqrt{\text{Discharge in cubic feet per minute.}}$$

This is then to be adjusted to suit standard diameters of pipes and nozzles or for other special conditions.

The symbols used are as follows :—

Q = quantity discharged per unit of time, lb./sec.
h = observed head, inches of water.
T = absolute temperature
= observed temperature ($t°$ F.) + 459·6.
m_2 = absolute pressure, downstream side, inches of mercury.
d_1 = diameter of pipe, upstream, inches.
d_2 = diameter of nozzle, downstream, inches
$n = (d_1/d_2)^2$.
M = coefficient for velocity of approach
$= n/\sqrt{(n^2-1)}$
$= 1 + \dfrac{1}{2\,n^2}$ approximately for n greater than 4·5.
δ = compressibility factor.
Ω = coefficient of discharge of nozzle.
Δ = specific gravity of gas relative to dry air at the same temperature and pressure.

Railway and Road Matters.

IT was announced in the House of Commons on December 9th, that the Minister of Transport has now appointed a Departmental Committee, under the chairmanship of Sir Henry Maybury, with the following terms of reference :—"To consider the existing system of 'Traffic Signs' as defined in Section 48 of the Road Traffic Act, 1930, and to make recommendations as to the exercise by the Minister of Transport of his powers under that section."

IT is announced by the London and North-Eastern Railway Company that Mr. R. F. Bennett, assistant engineer (construction) for the company's Southern Area, will retire under the age limit at the end of the year. Mr. R. J. M. Inglis, assistant engineer (permanent way) has been appointed assistant engineer (construction), and Mr. E. L. Hawkins, assistant engineer (maintenance) will in future be responsible for both general and permanent way maintenance under the Southern Area engineer.

ON Thursday, December 10th, the first portion of the 10.25 a.m. London and North-Eastern express from Newcastle to London, drawn by engine "No. 2547," of the "Pacific" type, covered the 76¼ miles between Peterborough and London in 66 minutes, including the 10 m.p.h. slack at New Southgate. It is said that a speed of 90 m.p.h. was reached in two places, and that the run was one of a series being made by the L. and N.E.R. Company in order to test the capacity of the most modern express locomotives in uphill running.

THE Ministry of Transport railway statistics for September have recently been issued as a Stationery Office publication, price 2s. 6d. They show that the number of passenger journeys, when compared with the corresponding month of 1930, decreased by 5·1 per cent. The drop, we notice, is fairly evenly divided between those at full fares and those travelling at reduced rates. This is a significant fall, as the loss has hitherto been caused by people paying reduced-fares at the expense of the full-fare receipts; now the cheaper fares are losing as many passengers as the full fares. Passenger train mileage was, however, reduced by only 2·7 per cent. The tonnage of the goods traffic decreased by 10·4 per cent. and the receipts therefrom by 6·7 per cent. Goods train mileage was brought down by 4·3 per cent. and the net ton-miles per engine hour was increased from 451¾ to 456, but the average train load fell from 125¾ to 123½ tons.

ONE of the two fatal accidents to railway servants during the first quarter of the present year, mentioned herein on November 20th, which were said to have been due to no look-out man having been provided, occurred to men carrying slag in containers for use as ballast across two main lines. Mr. Moore, the Assistant Inspecting Officer of Railways, who inquired into the accident, said that there could be no question that, having regard to the nature of the work and the locality and traffic generally, the undivided attention of a look-out man was needed, and the ganger neglected his duty by failing to appoint one. That man maintained that he was acting in accordance with the practice usually followed by this gang, namely, to employ a look-out man only when work was being done between platforms. Mr. Moore remarked as to this that "If, as is alleged, this practice has been allowed to continue unchallenged for a number of years, it indicates a very poor appreciation of the rules and a want of adequate supervision which should receive the attention of the company."

THE Board of Trade returns show that the value of the railway material sent overseas during the first ten months of the present year was as follows; the corresponding figures for 1930 and 1929 are added in brackets :—Locomotives, £1,491,674 (£3,010,412, £2,694,978); rails, £747,866 (£1,980,356, £2,292,398); carriages, £1,058,448 (£1,597,420, £2.075,577); wagons, £902,838 (£2,747,787, £2,070,360); wheels and axles, £162,024 (£332,409, £370,758); tires and axles, £262,905 (£553,975, £502,629); chairs and metal sleepers, £313,665 (£563,935, £412,427); miscellaneous permanent way, £375,245 (£747,415, £876,944); total permanent way, £1,898,154 (£4,269,127, £4,581,440). The weight of the rails exported was 89,882 tons (230,186 tons, 273,101 tons), and of the chairs and metal sleepers, 40,592 tons (59,203 tons, 40,685 tons). During the month of October last the value of the locomotives shipped was £109,654, which included: India, £56,520, and the Argentine £38,604. During the same period the rail exports amounted to £50,896, which covered: South Africa, £30,921; New Zealand, £6509; Portuguese East Africa, £5641; and the Argentine, £3339.

HERBIN, on July 24th, mention was made of a buffer-stop collision that had occurred on the 16th of that month at London Bridge station on the Southern Railway. The accident was inquired into by Lieut.-Colonel Woodhouse, whose report shows that the collision occurred at a very low speed, but there was telescoping between the second and third coaches. As Colonel Woodhouse observes, the thing, both as regards speed and damage, occurred at Charing Cross on September 19th, 1928, and Sir John Pringle, in his report thereon, recommended, as related in this column on December 28th, 1928, certain changes in the buffing arrangements on the coaches of the electrically operated stock. These recommendations were accepted, but at the date of the present accident only 140 out of 323 motor units had been converted. Those still to be altered are, however being taken out of traffic specially for the work to be carried out, in advance of their withdrawal for normal overhaul. The railway company, further, reported that occasional buffer-stop collisions in carriage sidings and severe impacts due to rough shunting, to which some motor units have been accidentally subjected after alteration, have been satisfactorily resisted by the central buffers in their new position. In addition, this type of buffing and draw-gear is to be adopted for some, at any rate, of the new stock being constructed for the extended electrification to Brighton. More than half of the existing stock has still to be converted, and as the progress is only at the rate of two to three motor units per week, it is recommended that the company consider the practicability of expediting the programme of conversion.

Notes and Memoranda.

A FACTORY representative of a large American tire company expresses the belief that the China market is gradually simmering down to a "second-line tire"—a line which most of the companies have been carrying for some time past and which is approximately 15 per cent. lower in price than the first-line tire range. This belief is based on two factors—the low purchasing power of interior consumers, which is further depleted by the abnormal silver exchange levels; and the fact that there are no facilities in the interior for the proper repair of tires. Interior purchasers for the most part want a tire at the cheapest procurable price; one which, when finished, can be thrown away, as there are no means available for repairs.

THE Home Office has now accepted the revised wording of a committee appointed by the Federation of British Industries and the National Confederation of Employers' Organisations in regard to the proposed new requirements concerning the inspection of boilers. The wording of the clause is now as follows :—"Brickwork must be removed for the purpose of thorough examination to the extent required by the person making the examination. It should in any case be removed to the extent necessary to expose the seams of shell boilers, and the drums and headers of water-tube boilers not less frequently than once in every six years in the case of a steam boiler situated in the open or exposed to the weather or to damp, and not less frequently than once in every ten years in the case of every other steam boiler."

IN the welding of manganese steel by means of the blow-pipe a manganese steel rod of the same composition as the bare metal must, says *Oxy-Acetylene Tips*, be used. The use of a flame having a slight excess of acetylene will assist somewhat in making a sound weld. A large flame should be used and a large pool of melted metal maintained. The rod should not be rubbed in the weld, but it should be left in the pool and melted under the surface of the liquid metal. When the pool is built up sufficiently it should be melted into the base metal by applying heat around the edges until the weld and base metal flow together of their own accord. The material should be preheated and reheated in a manner similar to the usual practice for cast iron. Because of the brittleness of red-hot manganese steel, care should be taken to support heavy pieces against strain during welding.

IN a recent investigation at the U.S. Bureau of Standards a study was made of aqueous solutions of ethylene, glycol, glycerine and sodium silicate to determine whether any of them offered promise as quenching media for steel with characteristic cooling rates intermediate between those of water and oil. It was found that the solutions of glycol and of glycerine did not give results which were readily reproducible. Hence, such solutions did not appear promising for practical use. However, solutions of several concentrations of sodium silicate proved to have quenching rates in the desired intermediate range and to give very consistent results. Some of these sodium silicate solutions must be treated with small additions of caustic soda in order to prevent changes in them when allowed to stand for several months. The effect of varying the concentration and the temperature of the sodium silicate solution was studied.

ACCORDING to E. P. S. Gardner, the present method of overlapping, hooking and tying reinforcement bars for concrete leaves in some respects much to be desired. On the other hand, by welding, reliable joints may be obtained, in which there is no danger of slip, that is to say, in which the transference of stress is definitely positive. Generally speaking, the welding operation is much simpler than hooking and tying, especially in heavy reinforcements. Considerable economies have already been effected in reinforced concrete construction by the adoption of welding, the main contributory factors being the saving in steel due to the elimination of the overlap and the reduction in labour costs. A further point of prime importance is the fact that a welded reinforcement frame is comparatively robust and may be handled without deformation, whereas when the members are tied, trouble and delay are sometimes experienced with distortion during handling and when the concrete is placed. The elimination of the necessity of threading bars at junctions may be considered in itself to render the application of electric welding worth while. Small tack welds are, of course, sufficient for connecting the bars, but the most suitable form of welded joint to adopt for the main reinforcement bars requires careful consideration.

IN the course of a paper on "Coke," read before the Institute of Fuel by Mr. R. A. Mott, he said that hardness in the coke is not *per se* of significance, but size is generally the predominant factor. According to the size of the hearth, unbroken coke, cobbles or doubles, single or pea coke nut sizes may be used. To provide an unsuitable size of coke is to create prejudice, for but little general knowledge exists among the public regarding the significance of size. As an example of this significance the case of a small coke boiler for domestic hot water supply in the writer's house might be mentioned. It had a fuel capacity of only about 0·5 cubic foot and has front doors which may be opened to give an open fire. When charged with a mixture of "walnut" and "apple" size of oven coke the boiler worked badly, went out several times daily, and gave a dull fire, which would have been of little value as an open fire, even if the front doors could have been opened sufficiently. On picking out the apple-size coke and using walnut-size only, the boiler worked so successfully that, once lit, it was unnecessary to close the front doors during the day, the fire picking up quickly on recharging without using the increased draught which could have been obtained. By adjusting the damper the ratio of combustion of the coke could be controlled to give a sufficiently bright fire, this adjustment being necessary because more than sufficient hot water for the domestic requirements was available. Double, single and pea size nuts from oven coke have been used, the singles being most satisfactory, the doubles tending to settle down too slowly and requiring longer time to "pick up" after recharging, whilst the peas tended to fall through the grate bars.

Miscellanea.

ABOUT one-fifth of Germany's mercantile tonnage is now laid up idle.

IT is proposed to abolish the Department of Forestry in the University of Cambridge.

A NEW oil refinery with a capacity of 1000 barrels a day has been put up at Manchester, Alberta.

IT has been decided by the Russian Soviet that the output of manganese shall be reduced by 40 per cent.

THE Yawata works, in Japan, are reported to be rolling railway metals of 74 lb. section in lengths of about 80ft.

A NEW wing has just been opened at the Stoke-on-Trent Technical College. It has cost £26,000, of which approximately one-half has been provided by the Central Miners' Welfare Fund.

SOME important deposits of fluorspar have been discovered in the Hlabisa and Nongoma districts of South Africa, and arrangements have been made for its export at the rate of 500 tons a month.

IT is anticipated that in 1937 there will be nearly two million acres of Central Asia under cotton. This area is greater than that in Egypt devoted to the same purpose and will make Russia independent of imported cotton. During the present year 42,000 acres have been sown.

WE are informed that the Brazilian Government is open to receive proposals for the electrification of the suburban lines of the Estrada de Ferro Central do Brasil, as also for the main interior line situated between the stations of Pedro II. and Barra do Pirahy. The Brazilian Embassy in London, which holds the official text containing the necessary information, will place it at the disposal of any interested parties.

IN view of the largely increased administrative demands upon municipal and county engineers, the Council of the Institution of Municipal and County Engineers has decided to introduce questions on administration and organisation into the Testamur examination, and also to inaugurate a Diploma in Administration for which a special examination will be held. The first examination for the Institution's Diploma in Administration will be held in November, 1932.

THE construction of a million dollar civic auditorium in Winnipeg as a joint relief project of the Dominion Government, the Government of Manitoba, and the Municipality of Winnipeg has just been formally approved. The Dominion Government has agreed to participate to the extent of 500,000 dollars. The building will be begun immediately, and will be closed in to permit of work being carried on all winter. It is to be completed by May 1st, 1932. The Governments will not contribute to either the furniture or the equipment.

THE latest returns of the National Federation of Iron and Steel Manufacturers show that the blast-furnaces in operation at the end of November numbered 70, compared with 66 at the end of October and 92 at the end of November, 1930. The production of pig iron amounted to 296,400 tons, compared with 284,200 tons in October and 384,100 tons in November, 1930. The production includes 68,000 tons of hematite, 123,500 tons of basic, 89,300 tons of foundry, and 11,000 tons of forge pig iron. The November output of steel ingots and castings amounted to 459,200 tons, compared with 457,400 tons in October and 433,800 tons in November, 1930.

THE Chinese Government has, according to *Commerce Reports*, of Washington, announced a very ambitious scheme for the dredging of the Fairy Flats at the mouth of the Yangtze River to be undertaken in 1933. The work has been entrusted to the engineer-in-chief of the Whangpoo Conservancy Board, and the programme includes work on the bar in the south channel for a period of five years. The Inspector-General of Customs has already authorised the collection of a conservancy tax, as from April 1st, 1931, on the basis of the actual import duties. The engineer-in-chief has explained his plans for the improvement of the south channel of the Yangtze as an improvement similar to that being made at the mouth of the Rio de la Plata in the approach to Buenos Aires, Argentina. A drag suction type of dredger will be used, which will not be anchored but will plough a groove down the channel under the thrust of the ship's propellers. The liquefied mud, as it is thrust away from the plough shares, will be sucked up into the hold of the dredger and emptied some miles away. Surveys are to be made shortly to determine where these dredgers are to do most of their work. It is stated that the dredgers will be about 300ft. long and will have a capacity five times as great as those now being used by the Whangpoo Conservancy Board.

IN describing to the Institution of Engineers in Australia his experiences of flying in the Antarctic, Mr. A. S. C. Campbell explained how the engine was warmed up for starting. The cowling below the engine was, he said, removed and a heavy cover of No. 1 canvas made to fit closely over the whole of the fuselage in front of the centre section. A hole was cut in this canvas cover directly beneath the engine crank case to take a canvas flue 1ft. in diameter, the other end of which was run down beside the funnel casing into the stokehold. An electric fan at the lower end forced a current of hot stokehold air—about 90 deg. Fah.—up through the flue and circulated it round the engine inside the cover. Under average conditions this heater would warm the engine up sufficiently for starting in about two hours, but it was usually kept going the whole time the weather was suitable for flying, so as to have the aircraft available at a moment's notice. Although this heater gave good results during the whole of the first cruise, it had many disadvantages, and for the second cruise a different method was adopted. Four 120-volt, 500-watt General Electric strip heaters were procured and permanently attached to the crank case of the engine. These were joined up in parallel and connected to the ship's 120 volt D.C. supply, through a two-point plug on the side of the fuselage. With the same canvas cover enclosing the front of the fuselage, this heater was considerably slower, and took about four hours to warm the engine up to a starting temperature from an initial deck temperature of 24 deg. Fah.

SHANGHAI WATERWORKS—NEW WATER PURIFICATION PLANT

MR. C. D. PEARSON, M. Inst. C.E., M.I. Mech. E., SHANGHAI, ENGINEER

(*For description see page 648*)

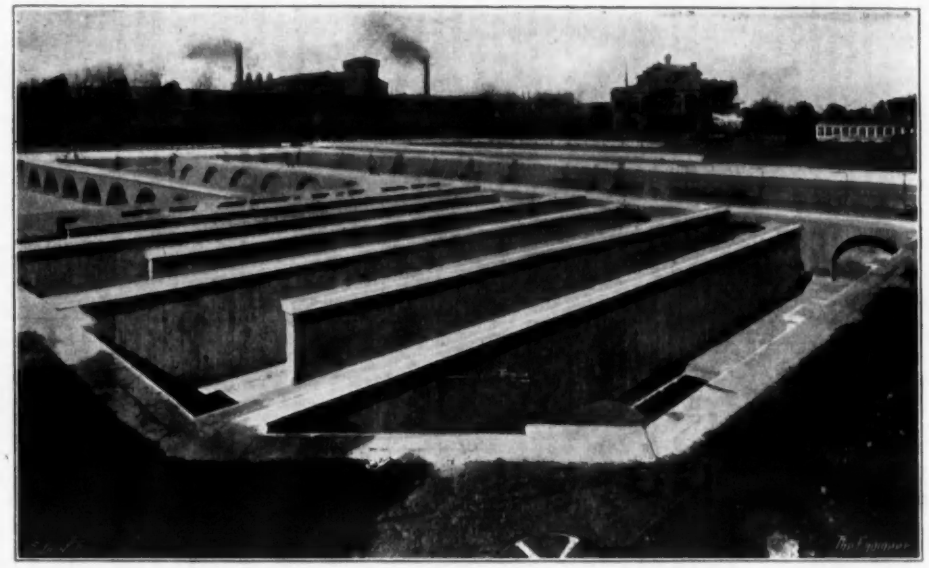


FIG. 8—LOW-LEVEL CONTINUOUS SETTLING TANK

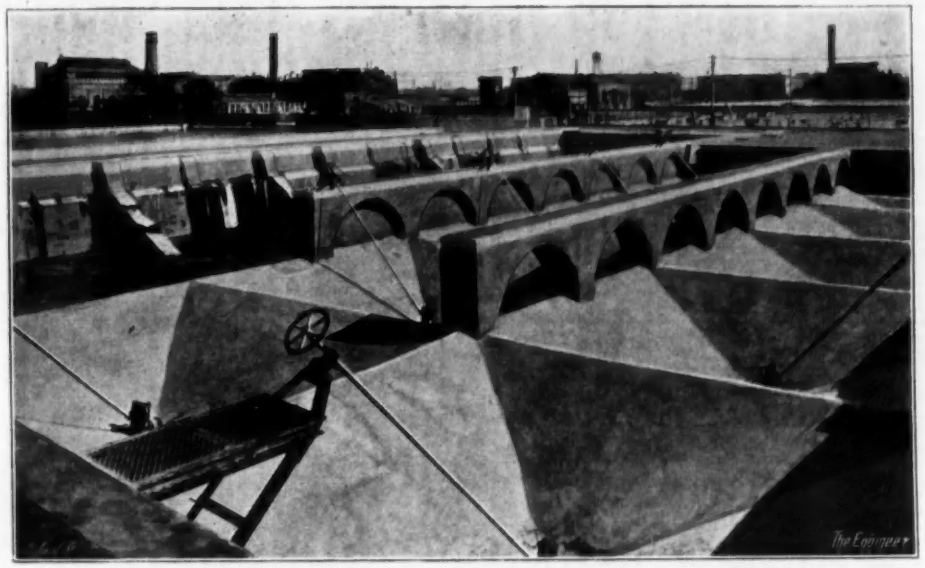


FIG. 9—SETTLING TANK, SHOWING BAFFLE WALL AND HOPPER POCKETS

FIG. 10—CLEANSING INTERMITTENT SETTLING TANK BY SLUICING

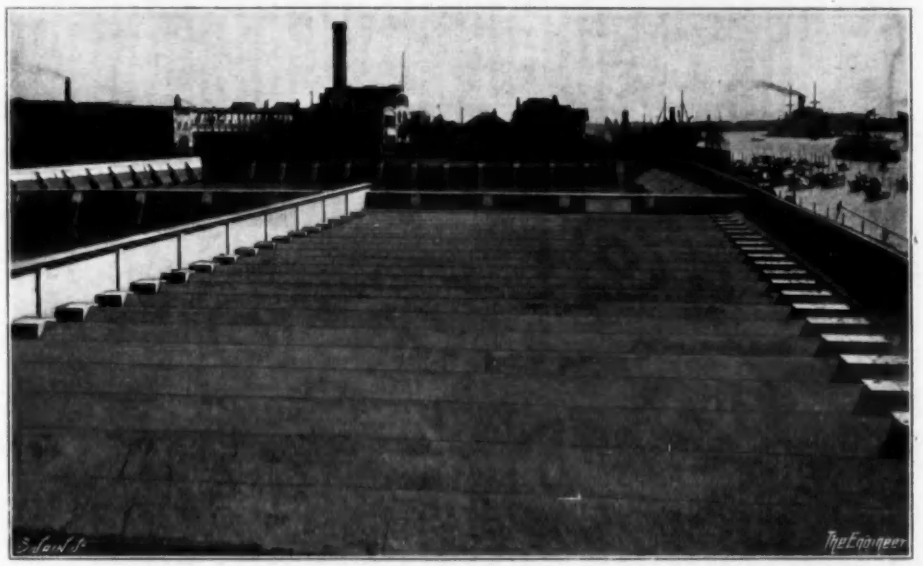


FIG. 11—CONTINUOUS HIGH-LEVEL SETTLING TANK WITH MUD-COLLECTING CHANNELS

The Engineer

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THE ENGINEER.

VOL. CLII. No. 3962

DECEMBER 18, 1931.

The New Cunard Liner.

THE heartburning with which the Cunard Steam Ship Company's statement last week regarding suspension of work on the new liner, known as "No. 534," now under construction at John Brown's Clydebank Yard, was received, has yielded, on calmer reflection, to a sense of the inevitableness of the decision. In a statement to the shareholders, the company outlined very clearly the reasons for building the ship, and the method of financing its construction, and pointed out that world conditions, which govern Atlantic traffic, had brought about changes in the outlook which rendered some postponement of the original plan advisable as a proper precaution. Owing to the reduced earnings this year, moreover, the company, for the first time in many years, has failed to obtain the sum required to cover the depreciation on its old ships. In building the new liner the company has made use of bill market finance, contracting to meet the liabilities partly out of the earnings which are annually set aside to cover the normal depreciation of the fleet, and partly out of the earnings of the ship herself during the first few years of her operation. The international crisis has now changed the entire financial background and rendered the continued use of that type of finance less easy than it was formerly. The suspension of construction has therefore been decided upon pending some change in the prospects.

The arguments advanced by the company are recognised as unanswerable, and the only hope of resumption lies in the earning of increased profits next year, or the adoption of some alternative means of financing the construction of the new liner, for which several schemes, from a Government subsidy to a public voluntary subscription, have already been advanced. Much as we desire, as engineers, to see the completion of this ship with a view to the recovery of the Blue Riband of the Atlantic, we are compelled to recognise that the Cunard Company cannot be expected to run a liner uneconomically and that suspension of her completion is therefore justified. Up to the present about £1,500,000 has been spent upon her in material and labour. That money has been expended on the completion of the greater portion of the hull structure—about 45,000 tons, we understand—and on part of the boiler, main propelling and auxiliary machinery installations. Had work on her continued, about £2,250,000 would have been spent in the near future on the interior passenger accommodation. It has been emphasised on more than one occasion that the Cunard Company is building the new liner out of its own resources, the only assistance given by the Government being in connection with insurance under the Cunard Insurance Act of 1930, and, of course, the promise of the normal mail-carrying subsidy when she is completed. The absence of direct State aid, we may point out, is a marked characteristic of British post-war shipping development in striking contrast with that of foreign competitors. Happily, owing to the self-reliance and initiative of British shipowners and shipbuilders, new and economical liners have entered the Australian, Canadian, South African and South American services and have sustained the well-recognised supremacy of British shipping. The country's prestige requires that the same be done for the Atlantic service. A beginning has been made with the White Star liners "Britannic," which is already in service, and the "Georgic," which will be completed next year ; but particular interest has always attached to the Cunard Company's decision to complete two huge liners, of which "No. 534" was one, to replace the three large ships at present carrying on the Cunard weekly express service. With those ships it was felt certain that Great Britain would recover the record for speed of which she has been deprived by the "Bremen" and the "Europa." Of the economical and national value of our reputation upon the high seas there can be no question, and it is the earnest hope of everyone that means of enabling the Cunard Company to fulfil its programme will be found. Whilst the question of the completion and operation of the liner is one personal to the Cunard Company, it has a national repercussion in that the discharge of several thousands of men from their employment on the fabric and fittings of the vessel puts a burden upon every taxpayer in the land. For this reason, no less than for the maintenance of our sea fame, the greatest public interest is being shown in the event, and we may feel certain that every possible step, either by the Government, by financiers, or possibly by the people themselves, which may ensure resumption of work at an early date, will be undertaken.

With regard to foreign competition, the statement recently made that work is to be retarded on the new French liner, the super "Ile de France," has been officially denied, but it is, nevertheless, a fact that the French Government, which is taking an important part in the reorganisation of the shipping company on behalf of which this liner is being constructed, is finding its task no light one. That French shipowners and shipbuilders are not unmindful of the difficult competitive situation in Atlantic trade may be inferred from the speech of Monsieur René Fould, on the occasion of the visit of the Institution of Naval Architects to the Penhöet Shipyard in July last, in which he advocated a closer study of the economic position, and the control of the output of ships, in such a way as would lead to a revived prosperity in the shipbuilding industry, and invited the co-operation of British interests in this matter. The question is now being taken further, and we understand that French shipping interests are endeavouring to arrange an international congress in the coming year. At it the demolition of obsolete ships, the rationalisation of traffic, and the restriction of future shipbuilding would be discussed by all the maritime nations of the world. The project is reported to have received official recognition, and the Naval Commission of the Chamber has already submitted several proposals.

Steel Sleepers.

IF any doubts existed in any minds about the technical success of the steel railway sleeper, they must have been completely dispelled by Mr. R. Carpmael's paper, and the discussion which followed it, at the Institution of Mechanical Engineers on Friday last. Steel sleepers, of various patterns, have been used in many parts of the world, under a wide range of climatic conditions, for many years. They have given no trouble, save in very adverse circumstances, and have, with due precautions, enjoyed long lives. The vast majority are employed for flat-bottomed rails and, in consequence, the designs

are simple, varying between the familiar pot, invented by Mr. James Livesey, and an inverted trough with or without bearing plates. In the United Kingdom the steel sleeper has been used for contractors and similar light railways for very many years. There, again, the rails are flat bottomed and the method of fastening is of great simplicity. As long as that rail section is employed there is no difficulty about the use of steel sleepers, and it is for that reason that they are more extensively employed on the Continent than in this country, whilst their popularity in the Tropics is due, also, in large measure to the fondness of the white ant for wood. When the bull-headed replaces the flat-bottomed rail the difficulties of design and construction are greatly increased. Although the history of invention goes back half-a-century and more, it is only within the last few years that manufacturers have been able to produce a design that satisfies railway engineers and is not prohibitive in price and weight. Four distinct types are now under trial on British railways. In one the chairs are formed by pressing tongues upwards from the sleeper body, in another they are cast in position on the sleepers, in a third they are pressed upwards from the body, and in a fourth they are welded on. The first two have been laid over long stretches and have proved themselves reliable. Whilst the mileage of the others is less and more recent, and not so much is known about them, there are already reasons for believing that they will prove satisfactory in service. Hence it may be said, without any reservations, that the technical questions have been solved. The running conditions are equally good. The evidence of witnesses shows that it is almost impossible to tell from the movement of a vehicle whether a train is on wooden or steel sleepers, and the noise has been overcome by the development of improved methods of packing the ballast.

If, then, technical perfection were the only criterion of the fitness of steel sleepers for British main lines there would be nothing to check their general adoption. Unfortunately, there are two items on the contra side of the account. One is the price of steel sleepers, and the other is their interference with track circuiting. One speaker at the Institution of Mechanical Engineers endeavoured to dismiss the latter with a gibe. But it is not to be so lightly disposed of. It is, in fact, a very real difficulty. A solution is, no doubt, possible and will be found in time, but until it is found the employment of steel sleepers will be barred where track circuiting is necessary. Price raises questions of a very different order. It involves, indeed, a rather complex problem of national finance. Put quite bluntly, it does not pay the railways to use steel sleepers. They cost, in round numbers, three shillings apiece more than wooden sleepers, and, in lack of actual figures, we assume that they cost about the same to lay. Hence the wide adoption of them must add something to the cost of transport, unless considerable reduction of the price is possible. It is sometimes argued that as the railways have to transport the ore, coal and limestone which are needed for the manufacture of the sleepers they benefit in the long run. But we suggest that there is a slight fallacy in the argument, and that Mr. C. J. Brown, of the L. and N.E. Railway, was justified in declining it. If a farmer carried the corn for his domestic consumption to the mill to be ground into flour one could not say that he got any profit at all from the cartage of the grain, and still less that the more grain he carried to the mill the better off he would be. If he were selling the flour to someone else then he might make a profit by charging for cartage, but if he wanted the flour for himself the more of it that he carried the greater would be the expense for cartage to which he was put. In the case of sleepers the railways charge the steel works for carriage of the raw materials, but whatever the works pay them for that service the railways have to pay back to the works in the price of the sleepers. Hence as the railways keep the sleepers for their own use they can only make a profit on them by increasing their rates for the carriage of passengers and general goods over the lines on which they are laid. There are other factors: the possibility, for example, of getting return loads for the trains carrying ore, coal and limestone to the works, and the sale of by-products by the steel makers, which may result in a balance in favour of the railway company; but, regarded in the simplest way, we incline to agree with Mr. Brown that the assumed advantage to the railways is absent or negligible. Yet whilst this direct benefit is lacking, it is certain that the railways do gain by encouraging the steel industry, which is one of their best customers, and, their own advantage apart, it is manifest that the nation benefits by the employment of its own raw materials—ore, coal, and limestone—instead of imported timber. That is one of the reasons, we have no doubt, which influences the railway groups in their encouragement of the steel sleeper. There remain, however, two other considerations. Steel sleepers cost at the present moment, complete with chairs, the extraordinarily low figure of fifteen shillings and sixpence apiece. That works out at £7 3s. per ton at a time when steel plates are quoted at about £9 per ton. But low as this price is, it is not impossible that it may be brought still lower when a standardised type of sleeper permits mass production to be developed up to the economic limit. At the same time there are reasons for expecting the price of imported timbers to rise. Hence ultimate parity of price is not unlikely. Finally, some advantage—rather distant perhaps—may be expected from the increased life of steel sleepers and the diminution of maintenance costs.

It is the habit of the day to think that everything which is new must be better than the old, and there are not wanting those who charge the railways with supineness for their adherence to wooden sleepers. The plain fact is that the wooden sleeper is just as good as, and perhaps a trifle better, than the steel sleeper, and that, at the present time, it costs about three shillings less. If we grew our timber there would not be the slightest reason for changing over to steel. It is even conceivable that for the sake of Empire trade we shall find it necessary or convenient to keep to wood. But for the time being, and in the national interest, it is desirable that the use of the steel sleeper should be extended and that the steel works should be encouraged to prosecute their search for methods, processes, and designs which will reduce the cost. Some inventors, baffled by the problem, rate the railways for sticking to the bull-headed rail. That is fruitless. A rapid change over to the flat-bottomed section is unthinkable. The problem has got to be solved for things as they are, and we have no doubt that through the co-operation of the railways and the steel works an economical solution will in the end be found. We trust, too, that electrical and signal engineers will direct their inventiveness to the question of track circuiting, for there is no doubt that it is one of real seriousness.

A Defence of the Engineer.

By Professor C. A. MIDDLETON-SMITH, M.Sc., M.I. Mech. E. of the University of Hong Kong.

THE choice of a trade or a profession for a boy is always difficult. There are very few youths who know enough about their own temperament and the world in which they live to be certain what work will best suit them. Yet often they are left to select a career for themselves.

Nor is it easy for the anxious parent to give the answer to this difficult problem. But the choice must be made. One result is that a large number of young men of all classes and with varying ideas set out to be trained as engineers.

It is a fact that many find the rewards of industry disappointing. After more than thirty years of experience in training engineering students, and watching their progress in the struggle to earn a livelihood, I would not recommend engineering to a young man who hoped to obtain money for the minimum expenditure of energy.

The rewards in other lines of life seem invariably to come to average individuals more easily. Considering only the professional class of engineers, it can be said that the modern system of training, which involves a university course and some form of student apprenticeship, is lengthy and expensive.

COMPENSATIONS.

That statement is not meant to discourage young men already training to be engineers. There are many compensations in our work. We may not, in general, obtain the same monetary rewards for ceaseless endeavours as do some of our friends in other jobs. We do, however, have an unceasing interest in our occupation. We have a simple faith that we are helping in a great work. We must believe in the new dynamic civilisation if we are to have enthusiasm for our efforts.

When, in 1896, my career as an engineering student commenced, my interest in applied science was aroused, not only by the technical Press, but by other current literature. It was of a type that has gone out of fashion. It can best be summed up in the words "Work will win." Samuel Smiles had given us the "Lives of Engineers," and addresses by prominent men led us to believe that engineering was work of great benefit to humanity.

THE NEW JEREMIAHS.

The heroes of my student days still have my respect, even reverence. Sir William White, Bessemer, Faraday, and others of their calibre, seemed to me then to make engineering not only respectable, but unique. For these men were not heroes because of their work, but because of their character. It was almost as if training had produced the character. Certain it is that their outlook on life inspired many of us to persevere in the sweat of the workshops and the toil of the study. Men of diverse temperaments, they all had this in common. They believed in their profession of engineering. They were absolutely certain that they were working for the benefit of humanity.

It is impossible to be an enthusiastic worker in any cause unless you believe in it. Men are actuated by all sorts of motives, it is true, but some of the best work in the world has been done by men who worked solely because they believed that they were doing a service to their fellows. From Faraday to Steinmetz is a list, too long to mention, of such men who helped to develop the new civilisation. Their work was something of a religion. They had no doubts of its noble purpose.

The youthful engineer of to-day, however, is less fortunate in this respect than were we. The new Jeremiahs are spreading the story of the impending collapse of the new civilisation.

Fortunately, there are others besides my generation of older engineers who refuse to believe these critics. It may encourage all of us engaged in engineering work to be reminded by these unbiassed believers, that the efforts devoted to improving machinery have not been in vain.

THE DECLINE OF THE WEST.

In Asia, as well as in Europe and America, writers are questioning engineers about the results of their work. They say that this dynamic civilisation is a gigantic failure. They assert that its only result is seething discontent, widespread bankruptcy, and universal trade depression. They warn us that throughout the world there is a great emotional revolt against the engineer and all his works. In Germany alone there have been sold 170,000 copies of Spengler's book "Decline of the West."

Reflect upon the admitted influence of Gandhi in Asia. There are many others in that vast continent doing their utmost to stem the advance of the new civilisation. Why?

There are two words which rouse to fury these critics of applied science. They are "mechanisation" and "standardisation." Those words represent the triumphs of engineers; but they are not final.

THE STATIC AND DYNAMIC OUTLOOK.

The real conflict between these critics and enthusiastic workers in applied science is in outlook on life. *They* believe in a static civilisation; *we* believe in a dynamic civilisation.

When the British trader went to India and the Far East, he took with him not only his goods, but his new ideas concerning power production and scientific education. For a long time Asiatics failed to respond to these missionaries of applied science. Now that the new gospel has permeated a little into Asia, a great controversy has arisen. Many of the Chinese classical scholars oppose the new ideas. There are, however, brilliant exceptions. This is what a Chinese scholar of distinction, Hu Shih, has written:—

> "A civilisation to be worthy of the name must be built upon material progress. As one of China's statesmen said twenty-six centuries ago, 'When food and clothing are sufficiently provided for, honour and disgrace can be distinguished; and when the granaries are full, the people will know good manners.'"

This Chinese writer of to-day continues his indictment of the static civilisation of his own country which he wishes to see replaced. "Picture a civilisation where boys and girls and old women with bamboo baskets tied to their backs, and with pointed sticks in hand, flock to every dumping place of garbage and search every heap of refuse for a possible torn piece of rag or a half-burnt piece of coal. How can we expect a moral or spiritual civilisation to grow up in such an atmosphere?"

In Chinese literature the order of honourable vocations is placed thus:—(1) The scholar, (2) the farmer, (3) the tradesman, and (4) the soldier. In practice, in China to-day, the soldier—including the bandit who is indistinguishable from the soldier in most parts of China—in the partial collapse of the static civilisation of the country, obtains the best rewards. Small wonder that when, in China, we read these indictments of "mechanisation" and "standardisation" we feel that at their worst these products of dynamic civilisation are better than "ignorance" and "brutality" which are to be found nearly everywhere in Asia to-day. At their best they produce order out of chaos. The terrible human suffering that exists to-day in China would be immensely reduced if the knowledge that gives control of the forces of Nature were more widespread.

When people in Britain read the "Decline of the West" and similar books, they should think of Asia to-day and even of the England of two centuries ago.

This industrial age has heaped upon us myriad comforts and amazing powers. Even the plumbing in our suburban houses would have seemed a luxury to kings of 300 years ago. Public sanitation and preventive medicine now protect us from a hundred

diseases that once imperilled every life and brought many to an early grave.

Poverty is real, but only in the slums can we discover it in England, and nowhere is there actual starvation. In China millions starve every year.

In England the amazing development and cheapness of mechanical power has brought within sight the realisation of Aristotle's dream when "the loom will weave of its own accord," and muscular power will be used only to re-create the health of the worker.

Last week in a foundry in the Midlands the conveyors and other mechanism made me wonder whether it really was a foundry, so different was it from the places with the same name wherein we worked thirty-five years ago. In an adjoining works, that once was filthy with dirt and moist with steam, electricity makes the place as clean as the home of a house-proud wife.

In China it is all so different, except in those few European settlements on the coast where the missionaries of applied science, from whatever motive, are demonstrating the new dynamic civilisation.

The sages of China taught the people that happiness may be found only in wisdom and in courtesy. For forty centuries the Chinese peasant tilled the soil with all the patience that attributes calamity to fate, blind and inhuman. To-day, the farmer in Manchuria, the boatman on the Yang-Tse, the coolie in Canton hears the roar of the aeroplane above his head, looks up and is roused to wonder by the machines with wings. No longer will the Chinese peasant keep his eyes to earth. This advance guard, in the air, of the new civilisation is stirring Asia from age-old thoughts to new ideas.

Two Classes of Humans.

In a notable contribution to the *Hibbert Journal*—a quarterly review of religion, theology, and philosophy—the editor, Dr. L. P. Jacks, writes, in more modern phraseology, the message that Samuel Smiles and the early engineers wrote many years ago. It is startling to find this defence of dynamic ideas made by an eminent theologian. He explains that if he had to part the human race into two classes he would divide them, not into sheep and goats, not even into saints and sinners, but into "men and fools." He is bold enough to suggest a new commandment, or shall we say he crystallises into a phrase the message of the old Samuel Smiles and the early engineers? From so eminent a religious leader the following statement is encouraging: "Behind all the moral laws I am acquainted with there is one great and fundamental command, which is not to be found in any of the traditional codes, but seems to me very plainly written in the general constitution of the Universe. . . . It runs as follows:—'Thou shalt play the man; thou shalt not play the fool.' Without that great rule as the foundation, all the others, for many of which I share the greatest respect, would collapse."

That should encourage the young engineer of to-day, who may find himself disheartened and perplexed by Spengler's writings, or Chesterton's words, or the critics of Asia. Thoughtful scientists realise that there is ample room for improvement in our modern civilisation. The substitution of electric power and gas for coal in cities and towns is merely one example that can be mentioned as an enormous benefit to humanity in recent years.

One final quotation from Dr. Jacks seems to be especially addressed to the young engineer: "A race which has emerged from the ignorance and brutality of barbaric ages is quite capable of emerging from mechanisation and standardisation, and will emerge if brave men stand to it."

It will emerge only if the old ideals which inspired those great pioneers of engineering science to play the man are present in the minds of the younger generation of engineers to-day.

During the last few weeks in England, some letters from young engineers—under thirty—have reached me. They mention the old trouble—lack of opportunity. Those who are disheartened might find consolation in reading the story of the pioneers of engineering in Britain. The world needs men of their tenacity of purpose just now. In spite of the pessimists, many of us believe that such men are in the ranks of the younger generation of engineers in Britain to-day. It seems to me that there is need for someone with the simple faith of old Samuel, but with the genius for the arresting phrase that is Chesterton's, to write anew for the young generation an attractive volume on the text "Work will win."

Obituary.

FREDERICK HARVEY TREVITHICK.

A link with the earliest history of locomotive engineering has been severed by the sudden death at Avignon, on December 9th, of Mr. F. H. Trevithick, who was on his way to Egypt, where he intended to spend the winter.

Frederick Harvey Trevithick was born in 1852. He was the son of Francis Trevithick, Chief Mechanical Engineer of the London and North-Western Railway, and grandson of Richard Trevithick, who built the first steam locomotive. It was therefore fitting that he, too, should become a locomotive engineer. After leaving Cheltenham College, he served his apprenticeship at the works of Messrs. Harvey and Co., of Hayle, in Cornwall, and then went through the drawing-office and shops of the works at Swindon of the Great Western Railway Company. That he did well there is evidenced by the facts that he first of all was made foreman of several of the shops and afterwards — actually in 1880 — became Superintendent of the Locomotive Department of the Company for the London District. That position he occupied for three years, when he was given the post of Ingénieur en Chef du Materiel et de la Traction of the Egyptian Railways, his designation, later, becoming, successively, Locomotive Carriage and Wagon Superintendent and Chief Mechanical Engineer. The whole of the remainder of his active professional career was spent in this employment.

On first arriving in Egypt he found that conditions regarding railways—as, indeed, in almost every other direction—were far from satisfactory. Locomotives and other rolling stock were antiquated and moribund, no renewals having been made for many years previously, and he immediately set about putting things straight and evolving order from chaos. In that work he was handicapped by having to meet an increasing traffic, while the funds at his disposal were drastically limited. Yet he did his work well; so well that when, twenty years or so later, a Commission was sent to Egypt to report on the general state of the railway system in the country, it found that everything was operating efficiently, and that there was nothing to which exception could be taken.

Having by rebuilding, renewing, and standardisation put the mechanical department of the railway system on a workmanlike footing, Mr. Trevithick proceeded to bring about improvements in efficiency of operation in all possible directions. With that object he instituted a numerous series of trials in such matters as superheating, feed heating, and air heating, and met with considerable success. The trials were continued over a number of years, and the results achieved by them were set out in a paper which he, in collaboration with Major P. J. Cowan, presented to the Institution of Mechanical Engineers in 1913, and which had the distinction of gaining a Willans Premium. That award, our readers will remember, is only made once every six years, alternately by the Institution of Mechanical Engineers and the Institution of Electrical Engineers, for what is considered to be the best paper read in the intervening period.

During the earlier part of his service, Mr. Trevithick's abilities marked him out as a suitable envoy for special investigations. As early as the year 1884—that is to say, only a year after he was first appointed—he was chosen by Lord Cromer to visit Russia in order to report on the petroleum industry in that country. Later, in 1896, he was sent to India to report on the railways there, and later still, in 1900, he went on a similar mission to the United States and Canada.

Throughout his long sojourn in Egypt, which we may say was prolonged beyond the age at which he might have retired with a pension, Mr. Trevithick won the esteem and respect of all with whom he had to do, whether European or native. He had a marked ability in gathering round him a staff of loyal and hardworking subordinates, and his retirement, when it did come about, was universally regretted. Returning to this country, he lived at Richmond, only wintering, of late years, abroad, and he continued to take an interest in the development of the locomotive to the end of his life. He was elected an Associate Member of the Institution of Civil Engineers in 1881—two years before he first went to Egypt—being transferred to the class of Member in 1891, and was made a member of the Institution of Mechanical Engineers in 1913. In recognition of his work in Egypt, the Orders of the Mesjidieh and Osmanieh were conferred upon him.

WILLIAM ROBINSON.

It is with great regret that we learn of the death, on Friday last, December 11th, of Professor William Robinson, M.E. (Queen's), Emeritus Professor of Engineering and Technology at the University College, Nottingham, and a recognised authority on oil engines. Professor Robinson, who was in his seventy-third year, died at his home in Malin, Lifford, County Donegal, where he had lived since his retirement from Nottingham about seven years ago. One of his favourite pursuits was forestry, and in 1908 he bought a practically bare piece of land on the extreme north-west coast of Ireland, which he drained and planted with pines, in the shelter of which and around his home other trees, shrubs and orchards flourished.

William Robinson was born in 1858 near Londonderry, and graduated at the Queen's University of Belfast, of which he was an honours student, gold medallist and first prizeman, obtaining his M.E. degree in civil and mechanical engineering. For two years he was at the University of Geneva, and was later on assistant to Professor Perry in the Department of Mechanical Engineering and Applied Mechanics at the City and Guilds of London Institute at Finsbury. For some time, also, he was on the staff of a firm of submarine cable manufacturers, and in that capacity he took part in a cable-laying expedition to the Gold Coast. In 1887, however, he returned to London to become the chief assistant to Professor Silvanus Thompson at Finsbury, a position which he continued to hold until his appointment to the Chair of Mechanical and Electrical Engineering at the University College, Nottingham, in 1890. His first task at Nottingham was to arrange the laboratories in the new wing of the technical department, which was then being built, and to design and to lay out to the best advantage the power plant and laboratory equipment. Following up his keen interest in gas and petroleum engines and liquid fuel, he specialised in those subjects and took an active part in the testing of many of the earlier engines. He was in close touch with the first stages of Akroyd Stuart's pioneer work and with the early Priestman and Hornsby oil engine developments, which are described in a most interesting manner in his recently published book, "Heavy-Oil Engines of Akroyd Type." His largest book is that on "Gas and Petroleum Engines," which was written for Professor Silvanus Thompson's series of "Finsbury Technical Manuals," and is looked upon as a standard work, more than one edition of it having been published.

After his retirement, Professor Robinson wrote, besides the heavy-oil engine book above referred to, a manual of applied thermo-dynamics, which covers the syllabus for engineering degree examinations and entrance examinations of the principal institutions. He wrote several papers on oil engines and liquid fuels and was awarded a silver medal by the Society of Arts for an early paper on the use of petroleum in prime movers, in which he stressed the value of liquid fuels for naval purposes and the importance of conserving oil supplies in our possessions abroad. Professor Robinson was a member of the Institution of Civil Engineers and of the Institution of Mechanical Engineers, and for some time of the Institution of Electrical Engineers. On his retirement from the University College, Nottingham, in 1924, he was made Emeritus Professor of Engineering and Technology.

Although as a teacher he was not, perhaps, to be compared with Silvanus Thompson and Perry, he nevertheless had a charm of manner which endeared him to his students, by whom in all parts of the world he is remembered with affection.

Literature.

Railway Literature, 1556–1830: A Handlist. By R. A. Peddie. London: Grafton and Co. Price 10s. 6d.—Those who are interested in the history of railways—of whom there are many—will find here a little book that fills a gap admirably. It contains the titles of all the books, pamphlets and articles that the author has been able to discover which were published on railways during their early evolution—plate wagon ways, wooden edge railways and iron railways—covering everything down to the time when the Liverpool and Manchester was firmly established, and was showing the world what could be done. There are four sixteenth century items, and three from the seventeenth, of which all but one are by Agricola, the "father of mineralogy." In the eighteenth century there are forty-eight entries, seventeen of which allude to Acts of Parliament; the earliest being that relating to the wagon-way of Charles Brandling (1758), which was at Middleton Colliery, near Leeds, where the "Blenkinsop-Murray" locomotives were introduced in 1812. The nineteenth century, down to 1830 only, comprises 709 items, 105 of which are Acts. Some editions of Stuarts—*i.e.*, R. Meikleham's—"Descriptive History of the Steam Engine" appear to be missing, as the third is entered under 1825, and the sixth, 1827. Galloway's "History of the Steam Engine" appears in 1826, 1827 and 1828, the last being called the second edition. It may be remarked that, in spite of what is said in the Preface, the reference to an American library always comes first. Students of railway history owe Mr. Peddie a debt of gratitude for the labour and care which has been bestowed on this book. It should be noted that foreign publications are included.

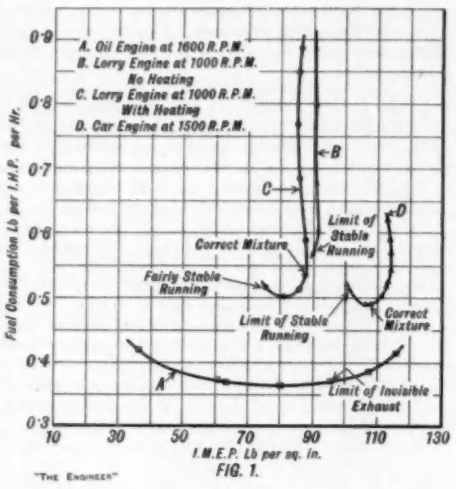
Michael Faraday and Some of his Contemporaries. By William Cramp. London: Sir Isaac Pitman and Sons, Ltd. Price 2s. 6d. net.—It is, of course, out of the question that the full life history of such a man as Faraday could be condensed within the limits of less than 70 pages in a small octavo volume. Yet the author has managed to paint, in that small space, an astonishingly life-like portrait of that great experimentalist, and to refer to the majority, at all events, of his greater discoveries. Moreover, he has managed to convey a remarkably clear impression of the scientist's character as a man. To have done those two things alone, in such small space, might be regarded as a noteworthy achievement, but Dr. Cramp has done much more than that. He has, first of all, succeeded in creating in the minds of his readers an accurate sense of the nature of the times in which Faraday worked; he has, in fact, imparted "atmosphere" to his writings which helps materially in their appreciation. Still more than that, he has embodied a series of sketch references—in a varying amount of detail—to contemporary workers in various departments of natural philosophy with whom the central figure in his memoir came into more or less intimate contact—Davy, Ampère, Gay Lussac, Berthollet, Laplace, Oersted, Dalton, Daniell, Brown, Brewster, and others. It is a delightful little book, and we have read it with great enjoyment.

It is proposed to install a central-heating plant in Toronto, Ontario, at a cost of 750,000 dollars. Two miles of pipe line will be required for the scheme.

Some Characteristics of High-speed Heavy-oil Engines.*

By S. J. DAVIES, Ph.D., M.Sc., M.I. Mech. E.

THE remark is often heard that progress in any one branch of technical development is rarely limited in its effects to that branch. Nevertheless, he would have been a very wise prophet who, witnessing in 1913 the successful attempts of Vickers, Ltd., to reduce weight by dispensing with air compressors on Diesel submarine engines, could foretell the effects of their success upon engines for lorries and omnibuses. It is also somewhat surprising that, in the face of the phenomenal progress made by the petrol engine during the past decade, the introduction of a rival type of engine, burning heavy oil, should be accomplished with such success. But, although designers of oil engines may well congratulate themselves upon this success, they should not overlook their indebtedness to their colleagues of the machine shops, the forge and the foundry, who, in meeting the increasing demands made upon them by designers of automobiles, have also contributed to those improvements in materials and accuracy of manufacture for which the high-speed oil engine has necessarily waited.


A. Oil Engine at 1600 R.P.M.
B. Lorry Engine at 1000 R.P.M. No Heating
C. Lorry Engine at 1000 R.P.M. With Heating
D. Car Engine at 1500 R.P.M.
Fuel Consumption Lb per I.H.P. per Hr.
I.M.E.P. Lb per sq. in.
Correct Mixture
Fairly Stable Running
Limit of Stable Running
Limit of Stable Running
Correct Mixture
Limit of Invisible Exhaust
"THE ENGINEER"
FIG. 1.

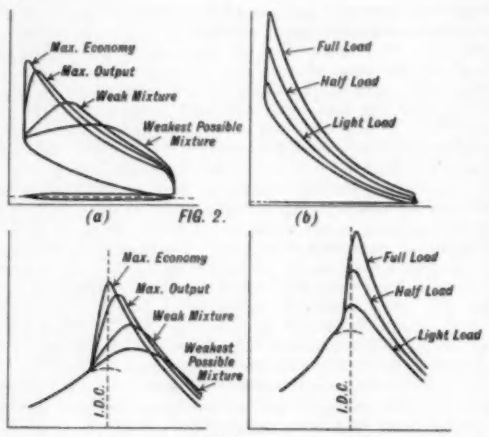


FIG. 2. FIG. 3.

In spite of the fact that, on the manufacturing side, there is considerable similarity in the problems presented by petrol engines and by heavy-oil engines, their characteristics in service offer some interesting points of difference. The broad advantages of the oil engine over the petrol engine for transport purposes may be summed up as :—A markedly lower fuel consumption by weight, and a still lower fuel consumption by bulk, particularly at low loads ; the use of a fuel which, under present market conditions, costs a fraction of that of petrol ; the use of a fuel that, on account of its high flash point, is relatively much safer than petrol ; reasonably complete combustion of the fuel, so that the proportion of carbon-monoxide in the exhaust gases is, under normal circumstances, quite negligible. On the other hand, the chief disadvantages of oil engines lie in the higher maximum pressures in the cylinders, and a higher ratio of maximum to mean effective pressures in the cylinders ; both of these circumstances tend towards higher weights per horse-power. These various points have, in recent times, received considerable prominence, and are generally well understood. There are, however, further differences in the characteristics of these two competing types of engine which merit study. These characteristics will be discussed in the earlier part of this paper, while, in the latter part, the present trend of design will be considered.

CYCLES OF OPERATION.

The differences between the cycles of operation in petrol engines and oil engines are often exaggerated. The rate of rise of pressure during combustion in high-speed oil engines is normally so high that the assumption of combustion at "constant pressure" is very wide of the truth. Actually, in many "injection" engines the increase of pressure is quite as rapid as in "explosion" engines, such as petrol and gas engines. As a result the "constant volume" cycle may quite reasonably be taken as the ideal cycle of comparison. The risk of pre-ignition, as understood in connection with petrol engines, being absent, it is possible, and, indeed, necessary, to use a higher ratio of compression. Thus, while the efficiency of the air standard cycle with a compression ratio of 5, as in petrol engines, is 47·3 per cent., that with a compression ratio of 15, as in oil engines, is 66·1 per cent.

Now, while the highest recorded indicated thermal efficiency of petrol engines, with the given compression ratio, is about 32 per cent., the best indicated thermal efficiency obtained with heavy-oil engines is of the order of 45 per cent. It is interesting to note also that the values of efficiency ratio—that is, $\frac{\text{actual thermal efficiency}}{\text{air standard efficiency}}$—obtained from the two types of engine are both about 0·68. Thus the better fuel economy obtained with the oil engine does not arise from a change of cycle from that of the petrol engine, but only from the fact that, while still working virtually on a constant volume cycle, a much higher compression ratio is used with "injection" engines than that possible with "explosion" engines.

BASIC CHARACTERISTICS OF PERFORMANCE.

Although it is highly desirable to have a clear conception of the relationship existing between the performances of engines and their ideal standards, much more than this is necessary if the practical performances of engines in service are to be compared. Fig. 1 shows four curves of consumption in pounds per I.H.P. per hour on I.M.E.P., plotted from the results of tests upon three engines. Curve A is from the author's tests of a six-cylinder heavy-oil engine of 110 mm. (4·32in.) bore and 160 mm. (6·3in.) stroke, running at 1600 r.p.m.;[1] curves B and C are from Ricardo's tests of a four-cylinder petrol lorry engine of 4·5in. bore and 5in. stroke—B without and C with heat added to the induction air—running at 1000 r.p.m.;[2] and curve D from the author's tests of a four-cylinder petrol engine of 63 mm. (2·48in.) bore and 120 mm. (4·72in.) stroke, running at 1500 r.p.m.[3] In carrying out the tests, the respective engines were, in effect, supplied with gradually decreasing quantities of fuel, and the corresponding brake loads and fuel consumptions observed. (See Appendix I. for a discussion of the methods of obtaining I.M.E.P. and I.H.P.) Thus, the actual independent variable in the tests is air/fuel ratio, since, in all cases, the variation of air consumption is relatively unimportant. Curves B, C and D are curves of the "hook" form usual with petrol engines ; they may appear a little unfamiliar on account of the scales it was necessary to adopt. Comparison of the petrol engine curves B, C and D with the oil engine curve A reveals the essential differences of performance which follow from the fundamentally different methods of operation of petrol engines and oil engines.

It should be remembered that the processes in the two types of engine differ in two important ways. First, in the petrol engine there is in the cylinder during compression a more or less homogeneous mixture of fuel and air, while in the oil engine the fuel is not injected into the air until towards the end of the compression stroke ; secondly, the propagation of combustion in the petrol engine proceeds from a single point, the sparking plug, through this mixture, while in the oil engine each particle of fuel injected into the air is, on finding its oxygen, a potential centre from which combustion may begin. The consequences of these differences are that, whereas in the oil engine each particle of fuel, as it were, looks after itself as regards its own combustion, in the petrol engine the instant of ignition of each particle of fuel is dependent upon the rate of propagation of combustion through the mixture.

That these rates of propagation are very different for mixtures of different strength is demonstrated by the indicator diagrams shown in Fig. 2 (*a*). The "hook" forms of the curves B, C and D in Fig. 1 are the direct result of this peculiarity of combustion. Starting at the top of these curves—that is, with the strongest mixture—and gradually increasing the air/fuel ratio, the M.E.P. or output at first increases slightly up to the maximum value. Continued reduction of fuel next leads to a fairly rapid falling off of M.E.P. until the point of minimum consumption, or maximum thermal efficiency, is reached. Before this point the mixture is "over-rich" and the rate of burning is reduced, leading to the lower thermal efficiencies. Further weakening beyond this point reduces the rate of burning proportionately much more, until eventually the burning is so slow that "popping back in the carburettor" follows. The M.E.P. falls off rapidly, and the thermal efficiency also decreases rapidly, as seen in the curves. The limit of satisfactory running is reached either through the running becoming too unstable, or by "popping back" occurring. In some engines—see curve B—this limit is reached before the actual point of maximum thermal efficiency can be passed. The differences in the areas of the diagrams of Fig. 2 (*a*) are small, corresponding of course to the very limited ranges of M.E.P. possible at full throttle, as shown also on curves B, C and D of Fig. 1.

In contrast with the petrol engine, it is seen from Fig. 2 (*b*) that all quantities of fuel are burnt in the oil engine at practically the same rate of combustion, since they all follow the same line of pressure rise. As a result, combustion is complete early in the expansion stroke, and all quantities are utilised, up to the limit of the air available, with practically the same indicated thermal efficiency. This is also clear from the very flat form of the curve A in Fig. 1. The upward sweep of this curve at the right indicates the approach of the condition when there is insufficient air to consume the increasing quantities of fuel, a condition accompanied in practice by a smoky exhaust. The upward trend at the left would appear to be caused mainly by slight imperfections in the fuel injection and metering. When the extraordinarily small quantities of fuel injected at light loads are borne in mind, this is hardly surprising. It is possible therefore with the oil engine to obtain very wide ranges of values of M.E.P., in addition to high indicated thermal efficiencies at all loads. In Fig. 3 (*a*) and (*b*) the indicator diagrams of Fig. 2 (*a*) and (*b*) from petrol and oil engines respectively, are given again, but on a base of crank angle. These diagrams further emphasise, on the one hand, the dependence of the rate of pressure rise in petrol engines upon mixture strength, and, on the other hand, the constancy of the rate of pressure rise with oil engines at varying rates of injection.

The main characteristics of the processes in petrol engines are therefore :—First, that the dependence of rates of pressure rise upon mixture strength restricts the mixtures which may be used to the range from about 20 per cent. weaker to about 40 per cent. stronger than that theoretically giving complete combustion ; secondly, the range of M.E.P. at constant throttle opening is relatively still more restricted, owing to the limited range of mixture strength, since the smallest M.E.P. is never, under the most favourable conditions, less than 70 per cent. of the maximum. The oil engine, on the contrary, will burn with approximately equal efficiency all fuel/air ratios, from the absolute weakest up to one only slightly weaker than that giving theoretically complete combustion. The range of M.E.P., always with full charging of the cylinder with air, is correspondingly extended from zero to the maximum. Thus, while with oil engines the fuel only requires to be regulated to obtain reduced outputs, with petrol engines, on account of the restricted range of mixture strength possible, the output is regulated mainly by altering the weight of charge by throttling. It is this difference of characteristic which leads to the exceptional advantage possessed by the oil engine over the petrol engine where "load flexibility," that is, a wide range of B.M.E.P. at any one speed, is demanded. These differences of regulation are important from the point of view of service, and merit further consideration.

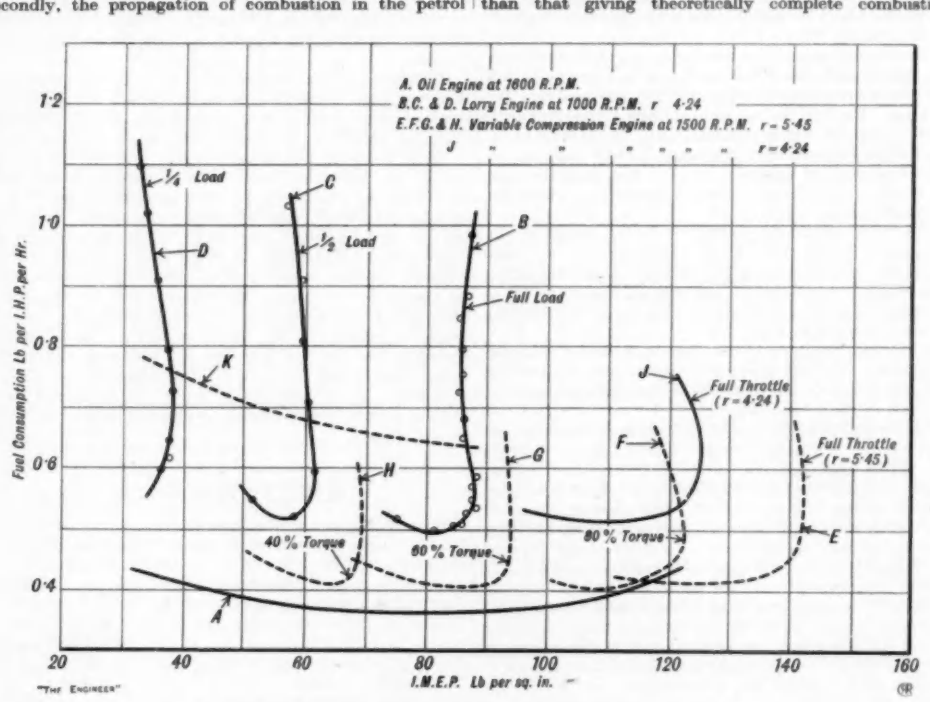

A. Oil Engine at 1600 R.P.M.
B.C. & D. Lorry Engine at 1000 R.P.M. r 4·24
E.F.G. & H. Variable Compression Engine at 1500 R.P.M. r = 5·45
J " " " " " " r = 4·24
Fuel Consumption Lb per I.H.P. per Hr.
I.M.E.P. Lb per sq. in.
¼ Load
½ Load
Full Load
Full Throttle (r = 4·24)
Full Throttle (r = 5·45)
40 % Torque
60 % Torque
80 % Torque
"THE ENGINEER"
FIG. 4—PETROL AND OIL ENGINE PERFORMANCES

Fig. 4 shows on a base of I.M.E.P. curves giving the performances of three engines at full and reduced outputs. Curve A is the curve A of Fig. 1 reproduced. Curves B, C, and D are all from Ricardo's tests of a petrol lorry

* Institution of Mechanical Engineers, Midland Branch, Birmingham, Thursday, December 17th.

[1] THE ENGINEER, October 16th, 1931.

[2] Report of Empire Motor Fuels Committee, I.A.E., Vol. XVIII., 1923–4.

[3] "Proc.," I. Mech. E., Vol. 120, p. 47, 1931.

engine,[4] B being actually curve C of Fig. 1. B, C, and D are tests at full, half and quarter throttle, the induction being suitably heated. Curves E, F, G, and H are curves from the Ricardo single-cylinder variable compression experimental engine at 40, 60, 80 and 100 per cent. torque, but whereas the ratio of compression in the lorry engine was 4·24 : 1, that of the experimental engine in series E, F, G, and H was 5·45. Curve J is one from this variable compression engine at the same compression ratio, 4·24 : 1, as in the lorry. These curves give opportunities for some interesting comparisons.

The relatively much better performance of the oil lorry engine, even when compared with the possible performance of the petrol lorry engine—that is, with extreme control over the carburation—is seen. But when it is considered that in the usual case, in which the setting at full load gives an "over-rich" mixture, the tendency with reduced throttle openings is to work on still richer mixtures, this advantage is yet more marked. The curve K, cutting curves B, C, and D, is an assumed one to give an idea of the probable "consumption on M.E.P." characteristic of the petrol engine. Curves E, F, G, and H are included to show how the characteristics of an exceptionally efficient single-cylinder petrol engine vary with throttle opening, and even here, with the high compression ratio of 5·45 : 1, and with no distribution losses, the lorry oil engine puts up a generally superior performance. Curve J is included to show a practically attainable performance at the compression ratio used in the petrol lorry engine. Curves A and K give therefore the practical characteristics of the oil and petrol engines respectively.

Equality of Cylinder Performance: Overload.

It is well known that unequal distribution of fuel to the cylinders of a multi-cylinder petrol engine largely accounts for the difference in performance between multi-cylinder engines and single-cylinder engines of the same cylinder form and dimensions. In this respect, too, the oil engines show up to advantage, since equal distribution

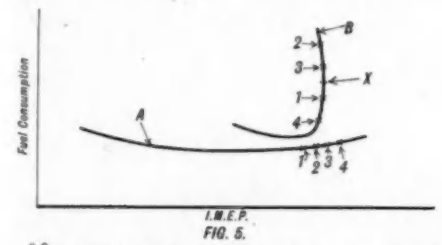


FIG. 5.

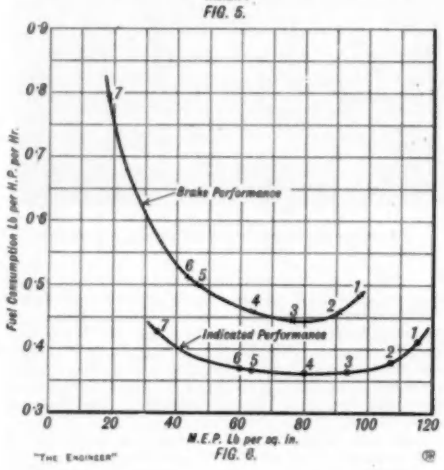


FIG. 6.

between cylinders can, in general, be realised within much closer limits than those possible with petrol engines. But, owing to the different characteristics of oil and petrol engines, inequality of distribution in an oil engine, when it is present to any considerable degree, has effects quite different from those of inequality of distribution in a petrol engine. Fig. 5 shows two curves, A from an oil engine and B from a petrol engine. Both engines are four-cylindered, and are developing approximately the same M.E.P. which, in the case of the petrol engine, can be assumed as that corresponding to maximum output.

With this output, and with the kind of inequality usual in a four-cylinder petrol engine, the points representing the performances of each of the four cylinders can be taken as 2, 3, 1, and 4, the mean consumption for the four cylinders being that given by point X. If inequality were absent, the same output could be realised if all cylinders were adjusted to give the performance of point 4. Thus the effect of the inequality of distribution is not to reduce the output appreciably, but to increase the specific and actual consumption of the engine.

In contrast to the petrol engine, the slope of the characteristic curve at maximum M.E.P. is, with the oil engine, horizontal instead of vertical. Thus the result of the kind of inequality given by points 1, 2, 3, and 4 on the oil engine curve is that, while the specific consumptions of all four cylinders are approximately the same, the outputs from the respective cylinders are different. Thus if one of the cylinders, No. 4, is on the limit of possible M.E.P.—as determined by the state of the exhaust—the other cylinders will be developing less than their maximum output, with a consequent reduction of the total output of the engine. Reference to Fig. 2 (*b*) shows that the exhaust temperature depends directly upon the weight of fuel burnt in a cylinder; readings of the exhaust temperatures from the individual cylinders, then, give direct indication of the degree of equality attained between the different cylinders. Equipment to this end has, for some time, been used on marine oil engines, and has proved an invaluable guide to the equality of performance of individual cylinders.

Fig. 5 shows a further difference between petrol and

[4] *Loc cit.*

oil engines. It is clear that, given the highest possible volumetric efficiency, the maximum output of a petrol engine of particular design has a quite definite meaning. It is impossible to increase the M.E.P. beyond the greatest value on the "hook" curve. The limit of output in the case of an oil engine is not so definite. A limit determined by the clearness of the exhaust would be fixed for engines working in towns or on frequented roads. In special cases, however, such as in aircraft while climbing or in transport engines working in mountainous or sparsely populated country, where the state of the exhaust is not so important to people other than the user of the engine, a higher M.E.P. accompanied by a smoky exhaust might be permitted for short periods of time. Continued running under such conditions is obviously not desirable. Thus, whereas the lorry oil engine referred to earlier developed 119·8 B.H.P., with an exhaust that would have satisfied the demands of a prolonged stop in the middle of London, 130 B.H.P. was developed when a less exacting, though still reasonable, standard of exhaust was accepted. Oil engines have therefore an overload capacity not possessed by petrol engines.

Speed Characteristics.

An aspect of the performance of oil engines, particularly those for vehicles, which, in the author's view, is not sufficiently emphasised, is that of their "speed characteristics." For the design of transmission gear, curves giving maximum torque and maximum horse-power on a base of speed are, of course, essential; but comparatively

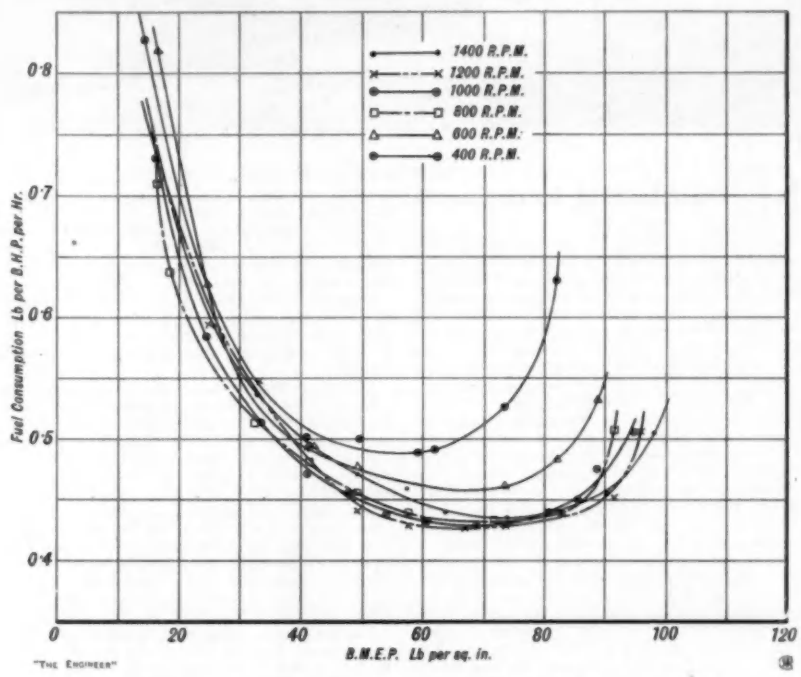


FIG. 7.—CURVES OF SPECIFIC CONSUMPTION OF AN OIL ENGINE

few builders of oil engines appear to consider it necessary to state the performances of their engines when developing reduced torques. Curves of fuel consumption in pounds per B.H.P., plotted on a base of B.M.E.P. over a range of load from light to full, for a series of constant speeds within the normal speed range of an engine, yield information of considerable value. They indicate the practical efficiencies of an engine under all its various conditions of running, and when it is remembered that many engines in vehicles work mostly at reduced B.M.E.P. it is clear that such curves are of much greater value than those giving mere maximum values They afford, further, a definite basis for the rather rough claims made for the greatly superior economy of the oil engine to that of the petrol engine when running under conditions of varying speed and load. In fact, with engines for vehicles, such curves constitute the real criterion of performance.

It is thus useful to consider such curves and the conditions which determine their forms. Fig. 6 shows two curves. The lower is curve A of Fig. 1, while the other gives data from the same tests, but in terms of B.M.E.P. and consumption in pounds per B.H.P. hour. The differences between these two curves at corresponding points 1, 2, &c., are due to mechanical losses, which are obviously affected by changes in B.M.E.P. These losses may be considered mainly under three headings: losses from pressure forces and auxiliaries; losses from inertia forces; pumping losses. In oil engines there is a slight decrease of the first with decreasing B.M.E.P., but the other two are roughly constant at constant speed. In petrol engines, however, the pumping losses increase considerably with decreasing B.M.E.P., owing to the increasing throttling of the induction; so that the corresponding curve for a petrol engine is, on this account alone, steeper in proportion, the brake consumption at reduced loads being relatively much greater.

In addition to variation with B.M.E.P., the mechanical losses will vary considerably with speed of revolution, and here, too, a comparison of oil engine performance with that of the petrol engine is interesting. The losses from pressure forces and auxiliaries, expressed as pounds per square inch of piston area, will not vary greatly with speed; against this those losses due to inertia forces and also to pumping increase as the square of the speed. Now, owing to the somewhat heavier reciprocating masses of oil engines necessary to withstand the higher cylinder pressures, the losses following from inertia forces are always correspondingly greater with oil engines than with petrol engines. But whereas the pumping conditions at full throttle with the petrol engine are similar to those with the oil engine, the petrol engine is, at reduced loads and particularly at high speeds, at a great disadvantage owing to the increased pumping losses by throttling, which more than offsets the gain by lower inertia losses. So that the differences, following from combustion conditions at full and at reduced loads, indicated by the curves K and A of petrol and oil engines, of Fig. 4, are added to when the brake curves instead of the indicated curves at the same speeds are taken; with increasing speeds of revolution these differences become still more marked

As a result the "speed characteristics" of oil engines are much more favourable than those of the petrol engine, and the impression which obtains in some quarters that the oil engine is not adapted to high speeds of revolution is quite false. Fig. 7 shows curves of specific consumption on brake mean pressure from a six-cylinder lorry engine.[5] The great similarity of form of these curves demonstrates that the practical efficiency of the engine is, within the range from 600 to 1400 r.p.m., almost independent of speed, and even at 400 r.p.m. the falling-off is much less than would be the case with a petrol engine. When it is seen that, from less than half torque to full torque and over a range of speeds from 600 to 1400 r.p.m., the fuel consumption is always less than 0·5 lb., the reason for the exceptional fuel economy or practical efficiency of the oil engine when running over wide ranges of speed and load is evident.

Apart from the question of practical efficiency, however, some interesting conclusions concerning combustion may be drawn from these curves. It would be reasonable to expect, from the increase of inertia and pumping losses with increase of speed mentioned earlier, that the curves with increasing speeds should lie higher and higher. That, on the contrary, the curves lie together show that to offset the increased mechanical losses the combustion or indicated thermal efficiency must have progressively improved with the speed. In fact, in no case with which the author is acquainted is there any sign of the limitation of combustion by speed of revolution. A second point is the satisfactory range of brake mean pressures possible at quite low speeds. Whereas a petrol engine will "tick over" at light loads quite well at low speeds, it will not, with the normal carburetter characteristics, respond readily to a demand for an increase of torque at the same speed. In this respect the oil engine, on account of the method of fuel supply, behaves much better, and "changing down" is, in consequence, not called for nearly so often.

Appendix I.

The engines of curves B and C and of curve D were both coupled to electrical dynamometers with swinging fields. The mechanical losses were measured by "motoring" the engines; expressed as "losses mean effective pressures," these were added to the brake mean effective pressures to give indicated mean effective pressures.

The oil engine of curve A was tested with a hydraulic brake, and its brake mean effective pressures only were directly determined. A very conservative value of 85 per cent. was assumed for the mechanical efficiency at the greatest load. This load was equivalent to a brake mean pressure of 98 lb., the corresponding "losses mean pressure" being then 17·3 lb. Since at the speed of running, 1600 r.p.m., by far the greatest proportion of this is due to inertia forces and to pumping losses, the reduction of this with reduced loads is very small. A progressive reduction from 17·3 lb. at the greatest brake mean pressure to 15 lb. at the least brake mean pressure was therefore assumed. In no case, however, could any reasonable error in these assumed values have any appreciable effect on curve A.

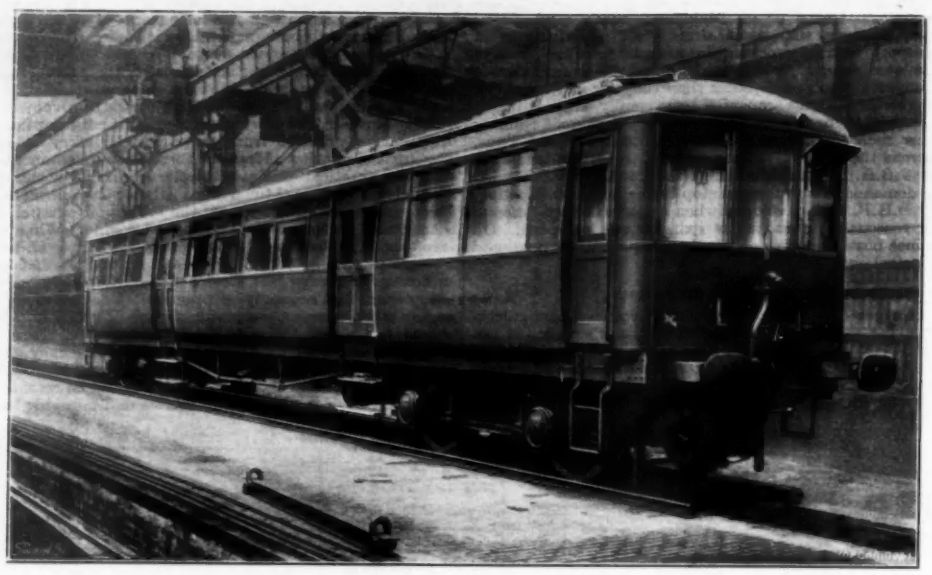
(To be continued.)

According to the *South African Mining and Engineering Journal*, local motorists have been assured that it is possible to produce, from native materials, petrol at a price of 5d. a gallon.

[5] The engine was the M.W.M. engine, and the author is indebted to the Sueddeutsche Bremsen A.G., of Munich, for these curves. See also THE ENGINEER, September 5th, 1930, and October 16th, 1931, for similar curves obtained by the author.

OIL-ELECTRIC RAILWAY COACH

SIR W. G. ARMSTRONG, WHITWORTH AND CO. (ENGINEERS), LTD., ENGINEERS



250 B.H.P. Oil-Electric Rail Coach.

RAIL motor coaches for branch line and lightly used services on secondary lines have been used for many years, and in many instances these light units have also been used for intermediate passenger services between country stations on main lines. This type of unit has been very widely developed in North America, where the availability of cheap motor spirit has led to the adoption of the petrol electric car in very large numbers and in powers of engine up to as much as 600 H.P. American cars generally have ample baggage and mail accommodation and the more powerful cars are used with one or two trailers and cover very long distances in sparsely populated districts. On the Continent of Europe the development of high-speed heavy-oil engines has led to the gradual adoption of oil-electric cars with a consequent reduction in fuel costs.

In the British Isles a few petrol-engined cars have been tried, but the steam car has up to now held the field. The railway companies of this country have, however, looked for some time for a satisfactory high-speed oil engine which could be adapted for use in rail motor coaches and could be relied upon to run with lower costs than has been found possible with the steam car. After many years of running experience on continental railways, Sulzer Brothers claim to have developed such an engine. The manufacture of this engine under licence has been taken up in this country by Sir W. G. Armstrong, Whitworth and Co. (Engineers), Ltd., of Newcastle-on-Tyne. Messrs. Armstrong, Whitworth have put down extensive special plant for manufacturing these engines cheaply in quantities, and have a wide range of sizes in production. In collaboration with the engineers and traffic officials of the four main line railway groups, Messrs. Armstrong, Whitworth have produced a standard form of oil-electric rail motor coach, which is claimed to meet as nearly as possible the requirements of rail motor coach services in this country.

The main criticism of the 100 H.P. steam coaches from the traffic point of view has been that they have not sufficient power to haul trailers and to maintain high schedule speeds under difficult conditions. Messrs. Armstrong, Whitworth have therefore adopted a considerably higher motive power by installing an engine of 250 B.H.P. The car is sufficiently heavily constructed to handle a 30-ton load at high speeds and the buffing gear is strong enough for light shunting for pick-up traffic. The first of three of these cars was completed early in November, and after preliminary works trials was inspected by Mr. H. N. Gresley, chief mechanical engineer of the London and North-Eastern Railway, at Newcastle on November 23rd. This rail car will shortly be handed over to the London and North-Eastern Railway and will be put into regular service on the branch and outlying lines in the neighbourhood of Newcastle some time towards the middle of next month. Later on it will be tried on other parts of the company's system. The remaining two cars are on the point of completion, and will be tested for running in multiple unit before being handed over for trial on the lines of the other British railway groups.

A feature of the electrical transmission is the provision of multiple unit control, whereby two or more of these coaches can be coupled together in rush hours and handled by one driver, no attendants being required in the engine compartments. In addition, should it be desired to use trailers regularly on certain services, the rear trailer can be fitted with a driving compartment and the set run backwards and forwards without reversing the trailers at terminals. This arrangement entails merely the fitting of the trailers with a light control cable and installing a controller in the rear compartment. The control of the car is automatic and simple, and the driver, to start or stop the train, has only to turn his controller handle.

Electrical transmission was chosen after very careful consideration of the actual results obtained with other methods in service. Early internal combustion engined cars were fitted with a mechanical gear-box and clutch, but experience soon showed that this arrangement was not sufficiently reliable, and that the maintenance costs were high and the life short. The maintenance costs and life of the engine were also very seriously affected. Electrical transmission, it is claimed, has proved its trustworthiness, long life, and low maintenance costs over many years. Its extreme flexibility permits of a higher overall operating efficiency than with any other system, and its ease of operation together with the control features mentioned above make it, it is argued, an ideal transmission.

The electrical transmission of the Armstrong-Whitworth standard car consists briefly of a direct-current generator, driven by the engine, supplying current to two standard traction motors geared to the axles of one bogie. The tractive effort of the motors is controlled by varying the voltage of the generator by means of an automatic field rheostat. The rheostat can be operated at the will of the driver or can be left to control the train automatically from start to stop.

The rail car measures 60ft. over the headstocks, and the body is built to a composite gauge enabling it to run anywhere in the British Isles with one or two minor exceptions. The following are the principal particulars of construction and performance :—

Seating capacity of car	60
Seating capacity of trailer, say	90
Total seating capacity	150
Luggage compartment area	47½ sq. ft.
Weight in working order	42 tons 10 cwt.
Maximum speed	65 m.p.h.
Starting tractive effort	6600 lb.

Balancing speed, fully loaded :

	Car only.	With 27 tons hauled.
On level	56–60 m.p.h.	50–55 m.p.h.
On 1 in 200 gradient	48 m.p.h.	41 m.p.h.
On 1 in 100 gradient	41 m.p.h.	30 m.p.h.

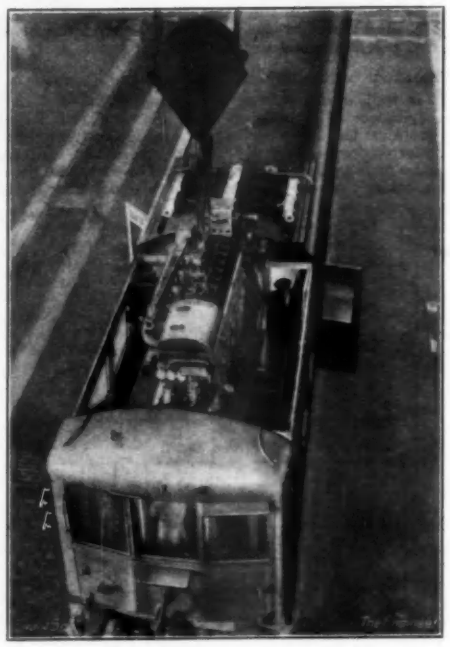
(The weight of a normal bogie trailer with ninety seats is taken as 27 tons with passengers.)

By fitting different gear ratios between the traction motors and the wheels, the maximum speed can be reduced and a greater load hauled. The particulars given are for a gear ratio chosen as suitable for average conditions in this country, where high schedule speeds are to be maintained. If the gradients are very heavy, a high gear ratio is necessary.

The coach is of steel construction. The underframe consists of two main solebars of rolled steel channel running the full length between the headstocks, and braced by longitudinal and cross members. Two longitudinal members also of rolled steel channel are securely riveted to the cross members by angles and knees. The headstocks are braced by diagonals and are stiffened by reinforcing plates running the full width top and bottom. Special construction is embodied at the engine-room end for supporting the engine generator set. The draw gear and buffers are of a light type, with screw couplings of standard form, of sufficient strength for the loads the car is intended to handle.

The bogie frames are built up of mild steel plates and sections. The plates are stiffened with blocked angles and the whole frame is braced with plates against lateral distortion. The bolster is supported on two nests of spiral springs carried on a mild steel channel spring plank slung from the bogie frame by adjustable swing links. The bolster guides are fitted with renewable cast iron liners, and the laminated bearing springs have rubber auxiliary springs. The axle-boxes are of the "Isothermos" self-lubricating type. Brake blocks with renewable shoes are fitted on both sides of all wheels, the brake power being 90 per cent. of the tare weight.

One of the bogies is provided with two standard axle-suspended electric traction motors, those in the car illustrated being supplied by the General Electric Company,

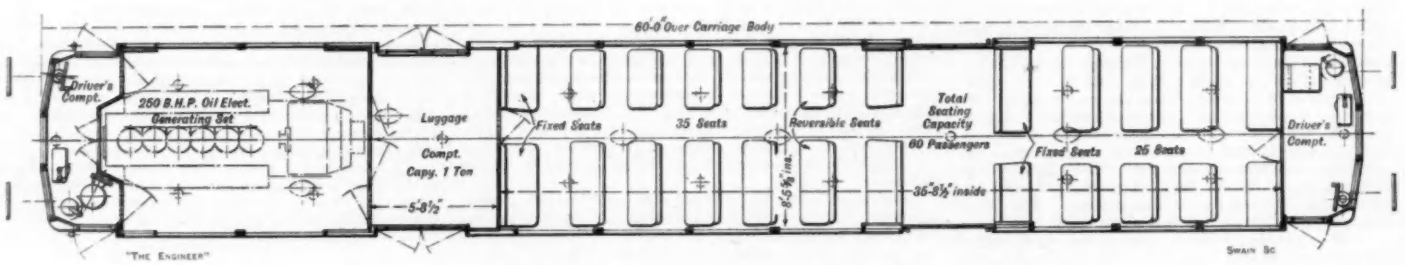


LOWERING POWER UNIT INTO POSITION

Ltd., of Witton. Spencer Moulton rubber-nose suspension springs are used, and the motor gears are enclosed in an oil-tight mild steel gear case. The underframe and bogies were built in the locomotive shops of Messrs. Armstrong, Whitworth. The body was built on to the underframe by Cravens Railway Carriage and Wagon Company, Ltd. The body framing is of rolled steel sections riveted and braced to the underframe. The sides and roof are covered with steel sheets.

The interior is divided into a passenger compartment with centre vestibule and double sliding doors, a luggage compartment with double swing doors, an engine-room and a driver's compartment at each end of the car. Electric lighting is obtained from the engine starting battery, a regulator keeping the voltage constant whether the battery is on charge or discharge. The heating is electrical from the main generator, strip heaters being fitted along the sides of the compartment, and heating and lighting couplers are provided for use with trailer coaches.

The roof of the engine-room upon which the radiators are mounted can be lifted off for removal of the engine generating set. Five pipe joints only have to be broken to effect the removal, the electric light wiring being provided with plugs and sockets. The vacuum brake equipment was supplied by the Consolidated Brake Company, Ltd. A Reavell rotary exhauster driven electrically is connected to the single train pipe system and to the vacuum horn. The train pipe is fitted at both ends with standard hoses and a passengers' emergency valve is provided in the vestibule. A hand brake wheel is fitted in both driving compartments. Foot-operated sanding is used for sanding the track in front of the foremost bogie in either direction of travel.



PLAN OF OIL-ELECTRIC RAILWAY COACH

THE POWER EQUIPMENT.

The six-cylinder engine is of the standard "Armstrong-Sulzer" four-stroke cycle locomotive type. The monobloc

cylinder casting is bolted down to a fabricated steel crank case. The generator frame is extended to form two vertical machined faces which are bolted to the engine crank case or sub-frame, the whole forming one rigid unit capable of resisting movements of the car frame. The connecting-rods are of chrome-nickel steel, the pistons of aluminium and the renewable cylinder liners of forged steel. Each cylinder has a separate water-cooled cylinder head carrying the inlet and exhaust valves with their rockers and the fuel injection valve. A separate fuel pump for each cylinder is arranged between the inlet and exhaust valve tappet rods. The valve gear is automatically lubricated, and with the fuel pumps is completely enclosed by aluminium casings in which inspection covers are formed. All moving parts of the engine are pressure-lubricated by means of a gear pump. An automatic device stops the engine in the event of a failure in the supply of lubricating oil or cooling water.

A centrifugal governor controls a shaft regulating the amount of fuel to be injected or to be by-passed. The engine runs at certain fixed speeds dependent upon the setting of the governor, which can be controlled by the driver. In the present case only two engine speeds, full speed and reduced speed, are required. Remote control of the fuel pump shaft is also provided to enable the driver to start or stop the engine. Aluminium end casings cover the governor and timing gears and the crank case inspection doors are also of alumiuium. The engine is started electrically by using the main generator as a motor, an engine starting battery of the alkaline or lead type being mounted under the floor of the middle of the rail car.

The main generator is a self-ventilated partially decompounded machine of a patented construction, which is claimed to allow great rigidity combined with light weight. An auxiliary generator is provided to supply excitation and control current and to charge the battery. The motor control apparatus, comprising fuses, contactors and reverser, is mounted in a case under the car. The generator control equipment consisting of an automatic field rheostat, ammeter, voltmeter, &c., is mounted in a cubicle in the engine-room, the driver's cabs only containing the apparatus essential for driving purposes, namely, the master controller, engine starting buttons, driver's brake valve, vacuum gauge, sanding pedal, whistle-operating lever, and the car lighting switches.

The cooling water for the engine is circulated under thermostatic control through radiators mounted in the roof. As the engine is normally shut down during station stops and when coasting, the water pump is, under these conditions, driven from the battery, as is also the rotary vacuum exhauster of the air brake system. The generator and auxiliary equipment were supplied by Laurence Scott and Electromotors, Ltd., and the electrical control equipment by the General Electric Company, Ltd., of Witton, both to Messrs. Armstrong, Whitworth's detailed specification.

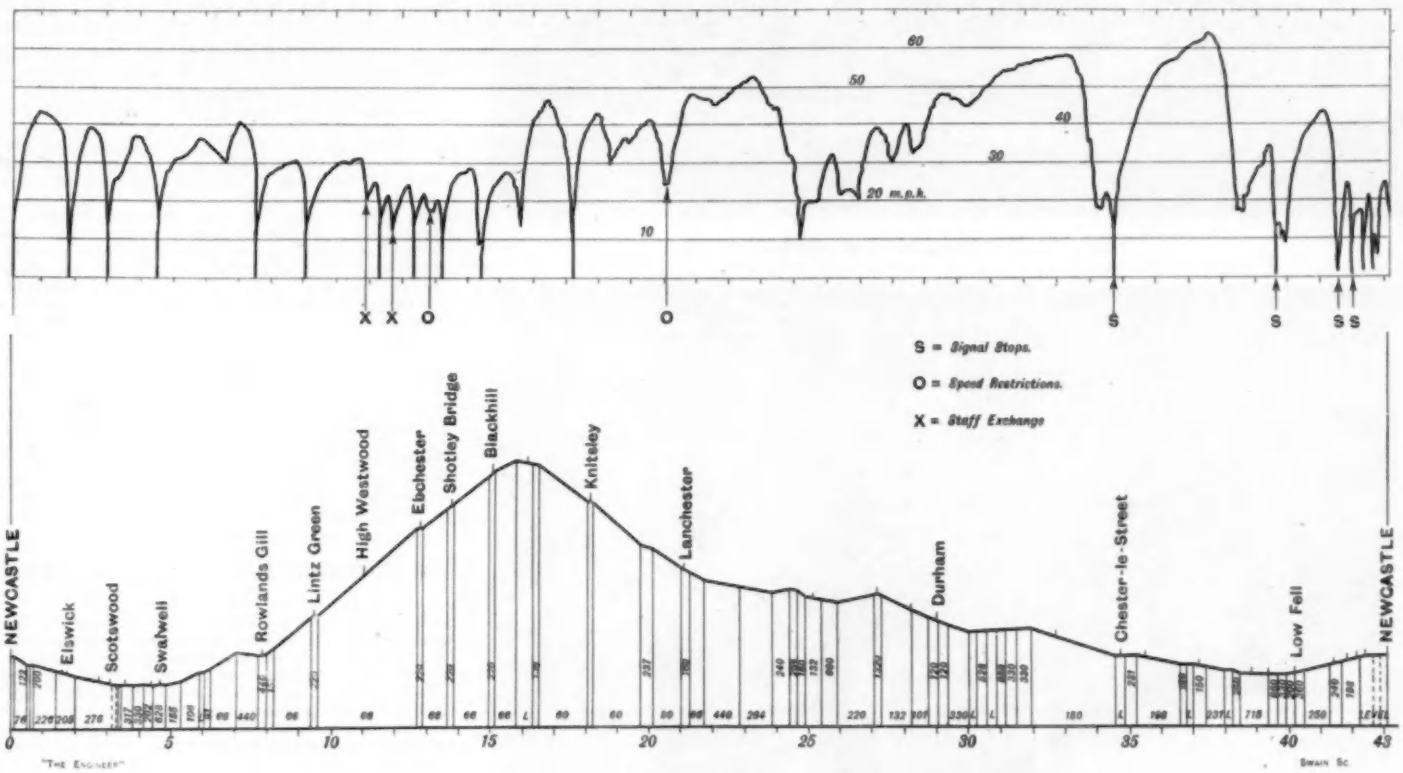
Automatic Features.

No attention whatever, it is claimed, is required in the engine-room when the rail car is in service. Safety devices shut down the engine in the event of any unusual occurrence, such as a failure of the cooling water or lubrication system. The rail car—or train, when several rail cars are coupled together—is driven by one man. The master controller is fitted with the usual dead man's handle, which, in the event of the driver removing his hand when the car is in motion, causes the brakes to be applied and power to be cut off. The driver selects the engine speed—full or reduced—which the trailing load and gradients to be encountered require, and moves his controller handle from "off" to "auto." The rail car accelerates and then runs automatically at constant engine horse-power, until it is desired to cut off the power, in which case the driver will normally move his controller handle back to "engine stop," and, in the case of short runs, coast the remainder of the distance.

An engine-starting push-button is placed at each look-out window, so that no time is lost in restarting the engine to begin the next run. An important feature is that, if, for any reason, a cylinder should misfire or have to be cut out of action, the control automatically reduces the load on the engine and the remaining five cylinders work at their normal load, and no overloading of the engine or electrical equipment is possible.

Trials on L.N.E.R. System.

The trials on November 23rd were carried out on the Newcastle-Blackhill and Blackhill-Durham routes, mainly on long gradients of 1 in 66, the usual steam car stopping service being maintained, and then on the Durham-Newcastle main line working to a special fast timing. The profile of these routes and Hasler speedometer record are shown herewith. In the case of the stopping service, for which the normal timing from Newcastle to Blackhill is 45 minutes, including eight station stops, or a running time of 41 minutes, the rail car running time was 34 minutes. On the homeward journey the rail car is reported to have shown excellent riding qualities at over 60 m.p.h., the maximum speed attained being 64 m.p.h. before slowing down for Lamesley. The number of stops between Blackhill and Chester-le-Street, was four, and between Chester-le-Street and Newcastle the number was three. Signal checks on this portion prevented sustained high speed.



TRIAL RUN OF OIL-ELECTRIC COACH—SPEEDOMETER RECORD AND PROFILE OF LINE

British Standards Institution.

All British Standard Specifications can be obtained from the Publications Department of the Institution at 28, Victoria-street, London, S.W. 1. The price of each specification is 2s. 2d. post free, unless otherwise stated.

AIR RECEIVERS.

Nos. 428, 429, 430—1931. These three new specifications form part of a series covering different methods of construction which is being prepared, and is the outcome of representations made by the Home Office.

The three new specifications issued cover Forged Welded Steel, Riveted Steel, and Solid-drawn Steel Air Receivers, and each provides for the quality of material used, the method of construction, and gives formulæ for the determination of plate and end thicknesses and requirements for workmanship and testing. The specification for Forge Welded Receivers—No. 428—also lays down details as to the methods of making forge welded joints for attaching the ends and also for inlet and outlet connections; and the Riveted Air Receiver specification—No. 429—lays down requirements for efficiencies of joints, thickness of butt straps, methods of riveting, and the staying of end plates.

In the preparation of these specifications careful consideration was given to existing regulations covering the construction of unfired pressure vessels, and they therefore represent a unification of these regulations which has been accepted by the authorities responsible for their preparation.

MANILA ROPES.

Nos. 431 and 432—1931. One of these specifications—(B.S.S. No. 431—1931) deals with Manila Ropes for General Purposes, such as for lifting blocks, slings, &c. It provides for ropes of three, four, and nine strands, and of three qualities, "Special," "Standard," and "Merchant," the qualities being so graded that the breaking strengths of a 3in. circumference three-strand rope would be 90 cwt., 80 cwt., and 70 cwt. respectively. In this way it is hoped that the specification will meet the requirements of all branches of industry. The specification for Manila Ropes for Well Drilling (No. 432—1931) includes two specifications, the first of which provides for drilling rope or cable for percussion well boring, and the second for the "Bull" and "Calf" ropes used on well-drilling rigs. The drilling rope, which is of three-strand construction, differs essentially from the "Bull" and "Calf" ropes, and from the ropes provided for in B.S.S. No. 432—1931, in that the conditions of use necessitate very hard lay, special lubrication, the highest procurable quality of fibre, and the maximum elasticity. Such a rope is not recommended for general purposes. Full descriptions of the testing required for the purchase of manila ropes are given in both specifications, while recommendations in regard to factors of safety are included in a Foreword to No. 431—1931. It is hoped at a future date after experimental investigation to add recommendations as to the minimum diameter of rope sheaves to give a reasonable endurance in sheaves.

It is of interest to note that consideration is also being given to the question of the preparation of a British Standard Specification for Fibre Cores for Wire Ropes.

RAIL DURABILITY.

Some little time back the South African Railway Administration decided to relay the railway line between Mafeking and Bulawayo on account of the heavier engines and larger train loads operating over this section. During the course of lifting the old rails and sleepers some very interesting details were disclosed, and are described in the *South African Engineer*. They demonstrate the lasting power of material of thirty to fifty years ago. The 45-lb. rails taken out of the track bore dates as far back as 1868–1875. These rails had evidently formed part of the old 4ft. 8½in. gauge line laid down from Cape Town to Wellington, and when the gauge of this section was converted to 3ft. 6in. the rails were transferred to other lines, being used later on the Vryburg to Mafeking line about the year 1894. As the volume of traffic to be hauled over the line increased, the latter section was relaid with 60 lb. material, and these old rails were then used in loops and sidings on the Mafeking-Bulawayo line and finally taken out in 1930. The weights of the trains running over these rails increased as time went on, until eventually the rails had to be replaced by the heavier type. The majority of the rails are still in an excellent state of preservation, and those that are serviceable are again being used on the Matopos branch, where the train loads are much lighter than on the main line, and their life is expected to be prolonged for a number of years under the lesser weight of trains. The history of the steel sleepers is also of interest, a number of them being dated 1895–1896. They were spaced 1936 to the mile, and were packed chiefly with sand. These sleepers have stood the strain of the increasing weight and speed of trains for thirty-six years, and a number can still be made use of where the traffic is lighter. The fact that this material is still free from rust is eloquent testimony of the quality of the material used in their production.

At the request of the American Institute of Chemical Engineers, the joint meeting with the Institution of Chemical Engineers in England, which was to have been held next year, has been postponed, owing to the present world economic position and the possibility that the disturbed economic conditions may last another year.

ELECTRICITY DEVELOPMENTS AT TUNBRIDGE WELLS

ENGLISH ELECTRIC COMPANY, LTD., STAFFORD, ENGINEERS

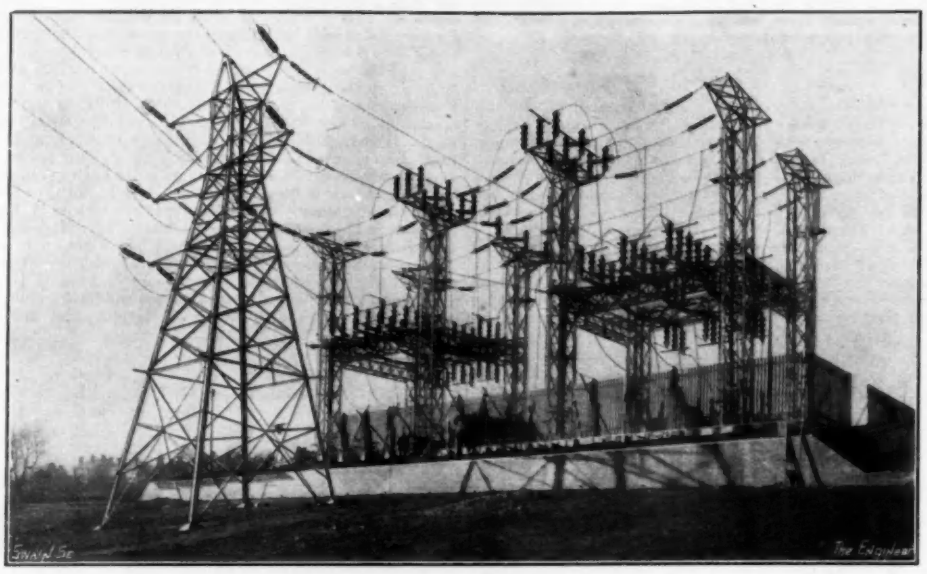


FIG. 1—132-kV OUTDOOR SUB-STATION

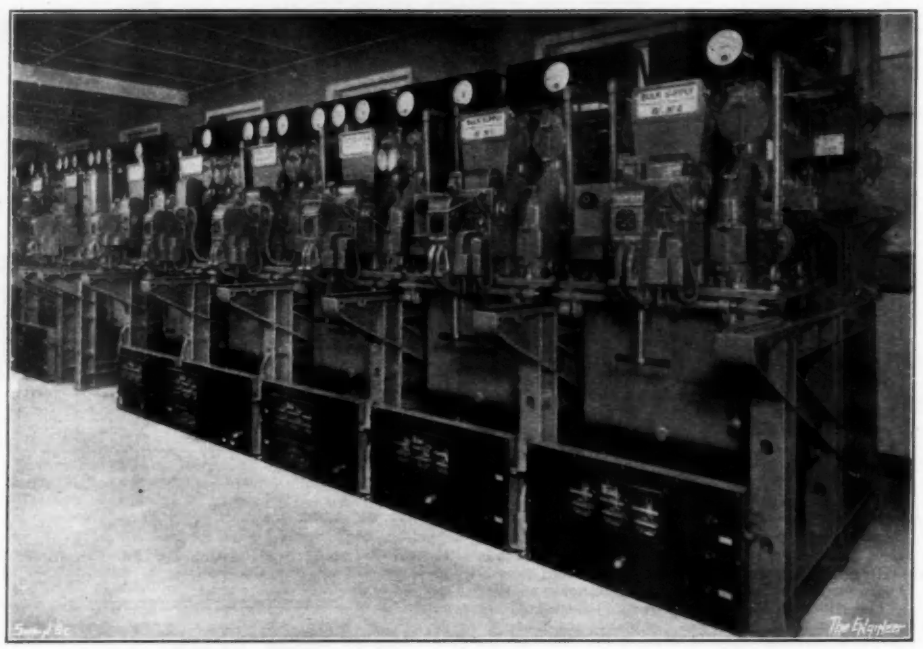


FIG. 2—METAL CLAD SWITCHGEAR

New Electrical Installations at Tunbridge Wells.

ON Thursday, December 17th, the official opening took place of the Central Electricity Board's 132-kV sub-station at Tunbridge Wells, and of the new main switchboard at the power station in Quarry-road. From the time of the opening of the original electricity works in 1895 until the complete reorganisation of the system in 1925 the supply was given in the form of single-phase alternating current at a periodicity of 67½ cycles per second. Even when the generating station was set to work it was realised that there would be a demand for electricity over a large and scattered area and a working pressure of 2000 volts was adopted. When in 1923 it became necessary to make a considerable extension to the generating plant, the Council decided to introduce the three-phase system and to change the frequency to 50 cycles, thereby bringing the system into line with standard practice. At the official inauguration on April 16th, 1925, it was recorded that the area of supply, including the bulk supplies given to the Tonbridge Urban District Council and the Weald Electric Supply Company, was approximately 360 square miles; the corresponding area at the present time being 550 square miles. The rapid development of the undertaking is indicated by the increase in the number of units sold, which during the last two years have shown an annual increase of 3½ millions, bringing the total up to 15 millions of units for the past year. Although the area is mainly of a residential and agricultural character, with few factories, the undertaking is able to show a load factor of 30 per cent.

The adoption of a unified national system of generation and transmission under the administration of the Central Electricity Board is said to be already influencing the development of electricity supply in Tunbridge Wells.

As in the case of the neighbouring towns of Brighton, Eastbourne and Hastings, a grid sub-station (as shown in Fig. 1) for receiving the 132-kV transmission line has been erected close to the power station, and a link is formed between the two by means of transformers and cables. The connecting up of the local power station to the "grid" marks an important stage in the history of the Tunbridge Wells undertaking, and it gives added importance and responsibility to the station as a distributing centre. By making available an unlimited supply of electric power it will facilitate the electrical development of the area in association with neighbouring supply systems. By means of a single three-phase overhead line, which continues south to sub-stations at Three Bridges and Brighton, the new sub-station is connected to the Board's Swanscombe sub-station, which is the largest in the country. Together with others at Eastbourne, Hastings, Folkestone, Canterbury and Maidstone these sub-stations are on a ring passing through Kent and Sussex. The new sub-station is of the "three switch high-extensible" type and is equipped with oil circuit breakers having a breaking capacity of 1½ million kVA, operated electrically from a central control board installed in the Corporation's power station. Two 15,000-kVA transformers give a 6600-volt supply for local use.

The connecting up of the Tunbridge Wells power station to the "grid" system naturally necessitated a careful review of the switchgear arrangements, in order that a proper standard of safety and continuity of service might be maintained when the plant in the station had been augmented by the supply from the "grid." Accordingly it was decided to install an entirely new main power station switchboard for the control of the incoming grid supply and of the power station generators. The board, which was constructed to the specification of Mr. R. N. Torpy, the Borough Electrical Engineer, in co-operation with the engineers of the Central Electricity Board, is of the most modern compound filled metal clad type and comprises twelve switching units, each having a capacity of 350,000 kVA at 6600 volts. The board—see Fig. 2—was constructed and installed by the English Electric Company, who were also the main contractors for the 132-kV grid sub-station at Tunbridge Wells, and twelve similar "grid" sub-stations in the southern portion of the South-East England Area.

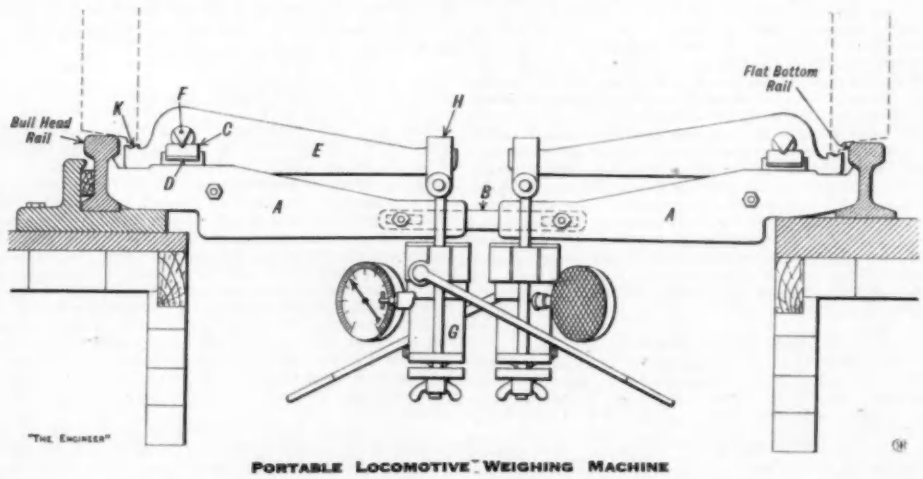
The switchboard is equipped with duplicate bus-bars to which any circuit can be selectively connected by means of special plugs, thus securing flexibility for grouping the various circuits and for isolating sections of the complete board for inspection or maintenance purposes. The main portion of each switching unit is the oil-immersed circuit breaker, which is a hand-operated switch designed to open automatically in the event of serious overload or other disturbance on the circuit which it controls. The oil tanks are constructed of heavy boiler plate and were tested to a pressure of 225 lb. per square inch before they left the factory. The two largest generating sets in the station are to be connected to this board and will therefore be capable of running in parallel with the "grid" lines. Two bulk supply feeders to the Tonbridge Urban District Council and two similar feeders to the Weald Electric Supply Company have also been transferred from the old switchboard, which, however, will be retained for controlling local feeders and will be fed from the new board, the two boards being interconnected by two cables with three-phase banks of oil-immersed air core current limiting reactors made by the English Electric Company.*

In order to utilise the available space in the most efficient manner the rearrangement of the switch room was carried out with much care. Besides the new main and old switchboard the room contains the whole of the equipment for controlling the Board's 132-kV outdoor sub-station and the measuring equipment for metering the power drawn from it by the Tunbridge Wells undertaking. These control and metering panels are mounted opposite the new switchboard in such a position that there is complete supervision of all the apparatus from a central point.

A Portable Locomotive Weighing Machine.

A HANDY form of weighing machine for locomotives and other railway vehicles is illustrated by the accompanying drawing. It is manufactured by the Transport Engineering and Equipment Company, of 24, York-place, Leeds, and is already in service on the L.N.E.R. and the L.M.S.R., while a machine has just been sent out to India.

The machine is intended for weighing the load on the wheels of a locomotive individually, so that the springs may be adjusted to distribute the load evenly, and thus minimise wear and tear on the moving parts. As will be seen from the drawing, it comprises two main frame pieces A A, which are connected together by a slotted link B, so that they can be adjusted to the gauge of the rails. These frame pieces rest on the lower flange of the rails, and are so shaped that they will fit flat-bottom or bull-head rails. On the top of the frames there are flat machined faces D, on which there rest hardened V blocks C for the reception of the knife edges F. These knife edges carry the weighing levers E. The levers have seatings K to engage the flanges of the wheels, and as the V blocks C can slide on the faces D the seatings will engage the flanges properly, regardless of the relative positions of the wheels and rails. The weight on the wheels is taken by the hydraulic jacks G, which pull down on the long arms of the levers through the links H. Thumb screws on the links are provided to take up the slack, and pressure gauges are used to give a direct reading of the weight.



PORTABLE LOCOMOTIVE WEIGHING MACHINE

The machine is sometimes provided with only one weighing lever, but it is then a simple matter to transfer from one side to the other. It weighs 3 cwt. 11 lb., and is made of cast steel. It is claimed that a shop fitter, working with one bearer, can weigh an eight-wheeled locomotive in thirty minutes.

* See THE ENGINEER, April 17th, 1931.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

General Conditions.

AGAIN this week there has been little change in the industrial position in the Midlands and Staffordshire. Work proceeds slowly in the iron and steel trades, and in most branches of engineering. In a number of the lighter trades there is a good deal of seasonal activity. Pressure at these works is not up to what it was at this time last year, but the position generally is considered to be fairly satisfactory. In the Black Country, thanks to some very welcome orders, the position at some of the engineering works continues to improve, and, taking the bad with the good, the position throughout Staffordshire and East Worcestershire is better than it was, and it would be safe to say that a little progress towards trade recovery has been made during the past six weeks. Of course, the approach of Christmas with its associated holiday period and stock-taking time has this week brought about a relaxation of forward movement. Efforts in many cases are being made to clear works before the vacation, while deliveries of raw material are only being taken as the material is required for use. Unfortunately, confidence in the New Year is not as marked as a few weeks ago, and the general tone of the Birmingham iron and steel market this week was lower than of late. There was little market activity on 'Change to-day—Thursday—and what business was transacted was put through, with the exception of galvanised sheets, at the prices ruling a week ago. Quiet conditions are likely to continue until the end of the year.

Sheet Prices.

Galvanised sheet prices have recovered ground during the past week. Firms which a week ago would have accepted £9 per ton for 24-gauge galvanised corrugateds now require £9 5s. The rise in the cost of spelter, the instability of sterling and an improved demand from overseas markets all affecting the situation. Midland mills are in an improved position, having received some considerable reinforcement to order books. Not only so, but makers are now inclined to a more favourable view of the immediate prospects. They note, however, that November exports were only of the value of £312,089, as against £323,731 in the corresponding month last year. On the past eleven months the value of galvanised sheets exported is down by roughly £2,800,000. Black sheets for the motor car industry are in slightly better request, but demand is still below normal for the time of the year. There is a little more movement locally in tin-plates, which, this week, are quoted 14s. 3d.

Raw Iron.

The pig iron position is practically unchanged on the week, and while current production is being absorbed existing stocks at the furnaces are not being drawn upon. In the Northamptonshire district these stocks remain rather heavy, but in Derbyshire there is little surplus material. Midland blast-furnacemen have substantial order books, but while specifications from the light foundry trade are good, those from the heavy department are disappointing. It is unfortunate that at a time when business is improving for Midland smelters activity in the pig iron consuming trades should be so unevenly distributed. There is little market activity at date, supplies having been arranged for in most instances to the beginning of 1932. Values are firmly held on the minimum level set by the Central Pig Iron Producers' Association, namely, Northamptonshire forge, £2 17s. 6d.; No. 3 foundry £3 2s. 6d.; Derbyshire and North Staffordshire prices stand alike at £3 1s. for forge and £3 6s. for No. 3 foundry. Prices are per ton delivered at stations in the Black Country. Inquiries this week fail to reveal any prospects of the relighting of furnaces in this district, at any rate for some to come.

Finished Iron.

Conditions are unaltered in the finished iron trade in Staffordshire. Mills are working irregularly and with fewer hands. Orders continue best in the marked bar and the strip departments, but even there there is ample room for improvement. The basis of selling prices is unchanged. Marked bars cost £12 at works, Crown bars vary between £9 5s. and £10; nut and bolt bars command £8 7s. 6d., while wrought iron gas tube strip is quoted £10 10s. to £10 12s. 6d. per ton delivered. Staffordshire ironmasters view the future with some concern; but there are a few who anticipate an improvement in the first quarter of the next year. They have little solid ground on which to found their optimism.

Steel.

The position at the steel works in this district is unsatisfactory, small specifications from consuming engineers being the rule. Rolling programmes are accordingly difficult to arrange. All descriptions of finished steel are similarly depressed, and it is probable that present selling rates would not be maintained were it not for the Association control scheme. The margin between native and foreign semi-finished steel prices has been reduced of late, but foreign material is obtainable still at much below local steelmasters' minimum prices. There is very little business passing either in home or foreign material, however, at date. Native steel works continue to quote £5 7s. 6d. for billets as against continental offers of supplies at £4 13s. to £4 15s. Re-rollers in Staffordshire ask £6 17s. 6d. for small bars, but buying has fallen away somewhat, consumers being of opinion that the figure is too high. For all-British bars quotations rise upward from £7 10s. Continental merchant bars are offered at £5 7s. delivered. The steel position on the whole must be written down as unsatisfactory.

Wright's Ropes.

Wright's Ropes, Ltd., of Birmingham, is among the favoured firms which have been able to show a profit on last year's working. After allocating £10,000 to depreciation, the annual report shows a net profit for the year of £15,301, which compares with a profit of £22,484 in the previous year. By omitting any appropriation to reserve, which last year received £5000, the distribution on ordinary shares for the year is maintained at 8¼ per cent., with a final dividend of 6¼ per cent. and £12,753 is carried forward as against £13,077 brought in.

Contracts for Midlands.

Amongst the recent orders given out by the Great Western Railway Company are some which have come to Midland firms. The Wolverhampton firm of Wilson Lovatt and Sons, Ltd., are to carry out extensions to a warehouse at South Lambeth. Walker Bros., Ltd., of Walsall, are to supply and erect steel roofing and contingent works at Morpeth Docks, Birkenhead.

Mining Engineers.

A well-attended meeting of the South Staffordshire and Warwickshire Institute of Mining Engineers was held on Monday at the University, Birmingham. During the afternoon the following papers were read:—"Some Notes on an Application of Pressure Surveying," by Mr. F. B. Hindley and Mr. J. Cecil Mitcheson, and "Spontaneous Firing of Coal from North Warwickshire Seams," by Mr. J. Ivon Graham and Mr. W. E. Raybould.

Proposed Sewerage Scheme.

The Rugeley Urban Council have approved a new sewerage scheme, which has been prepared by their engineers and which is estimated to cost approximately £30,000.

Birmingham Unemployed.

Unemployment in Birmingham continues to decrease steadily. The latest records show a fall on the week of 853, bringing the total to 60,401. It is worthy of comment that although the national figure shows the first increase for several weeks, there is a continuation of the fall in Birmingham, which has now been continuous since September 28th, the aggregate reduction being 14,579. The chief decrease in Birmingham is in women, but even in men, boys and girls there is a slight reduction in numbers.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

Attracting New Industries.

WIDESPREAD interest has been aroused by the activity of the Lancashire Industrial Development Council and more especially in the scheme propounded by Lord Derby at the conference held in Manchester under the auspices of the Council less than a month ago. Already there are indications that the Lancashire effort may eventually form part of a co-ordinated national development scheme. Meanwhile, a further Lancashire conference has been arranged to be held in Manchester on Thursday of this week to consider the proposed campaign in closer detail. It is interesting to note that, partly in consequence of the suspension of the gold standard, but due in part also to development efforts carried out locally, new branches of industry are being atracted to Liverpool and Manchester. Reports as to pending developments in three directions in the Liverpool district were in circulation during the early part of this week. None of these appears to be directly of engineering interest, but in the case of Manchester it is understood that the manufacture of welding apparatus, formerly imported from the United States, is contemplated in the near future by British Industrial Gases, Ltd., at the company's works in Trafford Park.

Textile Machinery Exports.

A feature of the overseas trade in British textile machinery during November is that whilst the quantity shipped was higher than in the corresponding month of last year, the value was appreciably lower. There is some satisfaction, however, to be derived from the fact that the value of the November exports was above the average for the eleven months of this year. The month's shipments of 5414 tons, valued at £458,662, included 3658 tons of spinning and twisting machinery worth £329,522, and 1346 tons of weaving machinery worth £80,493, the total comparing with 5261 tons and £515,044 in November, 1930. Exports to British India were higher at £168,250 than they were a year ago, and that country continues, in spite of the boycott and other troubles, to be easily the most important outlet for British textile machinery. Increases of varying extent were also shown in shipments to China, Japan, the United States, and Australia. Second to India in order of importance is Japan, with takings valued at £42,218, followed by China with £38,586, France £31,726, Russia £19,713, South America £18,560, the United States £15,874, the Netherlands £12,929, Germany £10,306, and Australia £7311, aggregate exports to "other European countries" amounting to £70,634.

Creosote Oil as a Motor Fuel.

Following upon a report by the city transport manager, Mr. J. S. P. Moffet, the Salford Transport Committee has decided to carry out an experiment with two omnibuses adapted to the consumption of creosote oil as fuel. One omnibus has already been fitted up and work on the other is proceeding. The oil is to be supplied by the city's gas department at a cost of about 4d. a gallon. Mr. S. E. Crooke, works manager and chief engineer of Crossley Motors, Ltd., commented on this development in the course of a paper on the possibilities of the Diesel engine for road transport, read last Friday before the Institute of Transport in Manchester. Mr. Crooke stated that in Belfast, where experiments with creosote oil and petrol as fuel have been carried out for some time, they were obtaining about 8½ miles per gallon with a single-deck omnibus, and it was found that the cost was approximately 0·78d. per mile. With a compression ignition engine, the fuel cost of the double-deck omnibuses operating in Manchester worked out at about 0·43d. per mile.

Machine Tool Makers' Profits.

For the twelve months to the end of last June, the profits of Kendall and Gent (1920), Ltd., machine tool makers, Manchester, show a slight increase from £3317 in the previous year to £3629.

Non-ferrous Metals.

The spell of firmness in the non-ferrous metals market has been succeeded by a week of reaction in all sections except tin, though to some extent the fall in values is due to the recovery in sterling. There seems to be little in the present position of copper to make for any material increase in values. Supplies of the metal are known to be exceedingly heavy—market estimates place them at about half a million tons—and the demand from consumers is at a very low level, with speculators also less active than than have been of late. The past week's fluctuations have served to wipe out the whole of the advance registered in the two previous weeks, current values of standard brands being lower on balance by about 35s. a ton compared with a week ago. The demand for tin, both in Europe and in the United States, is relatively small, but with a more "bullish" view being taken of the statistical position prices have been about maintained. Lead has lost ground to the extent of 15s. a ton, and is now back to where it was three weeks ago. Here again there is room for much improvement in consumption. Spelter is quiet and is 10s. cheaper on balance, current prices finishing up lower than they have been since early in November.

Iron and Steel.

A seasonal lull in the iron and steel markets has reduced new business in all sections to very small dimensions. Operations in certain branches of the Lancashire foundry trades are about maintained at the recently improved levels, but there is a general disposition to work on stocks of pig iron until after the holidays, and deliveries from the furnaces into this district are falling off. Quotations, however, are steady all round, with Derbyshire, Staffordshire and North-East Coast iron all quoted at 67s. per ton for delivery in the Manchester area, Northamptonshire at 65s. 6d., Scottish at about 87s., and West Coast hematite at 81s. Trade in bar iron is even quieter than before, with Lancashire Crown bars at £9 15s. per ton, and No. 2 material at £8 5s. Constructional engineers are understood to be dealing with more inquiry, but actual operations at most works in this important branch are as bad as they have ever been, and very little steel buying is going on. Locomotive builders and boilermakers are also unsatisfactorily situated, although there has recently been a little more inquiry about for plates and other materials for tendering purposes. The demand for special steels is quieter than it has been of late. Boiler plates are easier at about £8 15s. per ton, but in all other respects the market is unchanged.

BARROW-IN-FURNESS.

Hematite.

The market is dull and with the falling off in demand for iron on steel account, the requirements are thin. It would almost appear as if some buyers have bought above their requirements, for there is a falling off in inquiries. The home trade has become quiet, and buyers are only taking small tonnages, just sufficient to keep them going. As regards American and continental trade, very little is being done, it being obvious that all countries are experiencing the same slackness. Stocks are still at a fairly heavy figure in the district, and there does not seem much hope of them coming down. Iron ore is in quiet demand, consequent upon the slackness in the iron trade. The steel trade is quiet, and few orders are available. The Barrow rail mills have closed down for Christmas, but there is some hope of them being restarted in the New Year. Shipping is very quiet.

Important Staff Changes.

Important staff changes are taking place at the Barrow Hematite Steel Company's works. Mr. A. Frank Mason, who has been commercial manager for upwards of twenty years, is relinquishing his present duties for health reasons, but he will continue with the firm as consultant. Mr. F. P. List, who has for some years been general works manager, is retiring at the end of the year. Mr. John Davison, who has been joint commercial manager and secretary of the company in London, has been appointed general manager, and Mr. Richard Spencer, of Messrs. Dorman and Long, Middlesbrough, who was previously connected with the company, is to be the new steel works manager. Mr. W. Killingbeck, the chief accountant, is to be the secretary to the company, and assistant to the general manager.

SHEFFIELD.

(From our own Correspondent.)

No Tariff on Steel.

THE attempts of the Sheffield Members of Parliament and others to obtain a tariff for the iron and steel industries have not been successful so far. The question was raised in the House of Commons last week, but the President of the Board of Trade, pointing out the extreme complexity of the problem, held out no prospect of tariffs in the near future. It is still hoped, however, that some protection will be granted to the industries before long. Mr. C. F. Pike, Member of Parliament for Attercliffe, in a speech in his division last Friday, said the heavy trades of Sheffield could rest assured that Parliament was watching their interests, and that a full schedule of tariffs against foreign dumping was in course of preparation. The Shef-

field Chamber of Commerce has intimated to Mr. Runciman that Sheffield industrialists and merchants would raise no objection to a general tariff on iron and steel, provided only that a special exemption was made for imports of charcoal-smelted pig iron, charcoal-smelted foundry iron, and steel made entirely from charcoal-smelted iron. These only constitute 1 per cent. of iron and steel imports by weight and 3 per cent. by value. Mr. Runciman has also been told from another authoritative source in Sheffield that if a general tariff is imposed on iron and steel, one leading firm will erect a complete Bessemer plant in the Midlands to make this type of steel, which at present is imported, but is not made in the United Kingdom.

Imports and Production.

The Board of Trade returns for November show a considerable increase in the importation of iron and steel, the tonnage being 379,363, as against 275,695 in October and 209,769 in November last year. Sheet bars and tin-plate bars were imported to the extent of 109,378 tons last month, as compared with 68,574 tons in October. The importation of special steels, however, showed a decrease. The latest figures of production relate to October, and they show that, while this district recorded some improvement on September, it did not reach the level of a year ago. The production of steel ingots and castings in the Sheffield area was 75,700 tons in October last, as compared with 50,000 tons in September, and 83,700 tons in October of 1930. The total included 23,600 tons of acid and 45,900 tons of basic steel. Lincolnshire did not show as much progress. Its total for October was 36,600 tons, comparing with 30,100 tons in September and 50,100 tons in October last year. The basic pig iron production of Lincolnshire in October was 32,200 tons, showing a slight improvement upon the 31,000 tons of September, but a heavy fall from the 54,200 tons of October, 1930. It is questionable whether Sheffield is at present maintaining its October level. The number of furnaces in operation shows little change, but some of the firms are finding difficulty in disposing of their output. In Lincolnshire, the outlook is reported to be a little brighter. Output is being increased at the Normanby Park works. It is rumoured that the Redbourne Hill works may restart soon, and there may be more foundation for this statement than for previous ones of the same character. Men are at work putting the blast-furnaces in order, which is a hopeful sign. Should a tariff be imposed on imported tin-plate bars, these works are almost certain to be restarted.

The General Position.

In several departments of the local steel trade, a shrinkage of work and orders is reported. Preparations are being made for the Christmas holiday, which in some instances is likely to be extended. Work had fallen to a very low ebb before the suspension of the gold standard, and that event resulted in consumers of Sheffield products, who anticipated a general revival, placing orders more freely than they had done for a long time. This improvement, however, was not continued, and, although its effects are not worn off yet, it has been waning gradually for the last month. There are no changes in the prices of iron and steel materials, but steel scrap is not quite so strong. The current figure for basic scrap is 42s. per ton.

Heavy Manufacturing.

The demand for railway steel continues poor, and the shops devoted to the production of axles, tires, and springs are badly off for work. There is little doing in shipbuilding steel. The suspension of work on the great Cunard liner at Clydebank will not affect Sheffield from an engineering point of view, as everything that was to be done by the builders—John Brown and Co., Ltd.—at their local works, has been completed. All the castings and forgings were made here, and provided a great deal of work for twelve months. The repeat order for a "Monarch of Bermuda," placed by Furness, Withy and Co., Ltd., with Vickers-Armstrongs, at Barrow, has, as I anticipated last week, brought work to Sheffield. The Vickers works of the English Steel Corporation will again supply the forged steel propeller shafts, stainless steel bars for valve spindles, &c., stainless steel castings, valves, and solid drawn tubes, and some of this work is already in progress. There is still a good deal of work on hand at the two local plants engaged on the production of hollow rolled boiler drums, turbine drums, and various containers, which have been working at high pressure for a long period, and have executed some valuable foreign orders. About 120 one-piece drums were supplied by Sheffield for the new Cunarder at Clydebank. A drum or container weighing 100 tons has been rolled by this process. Progress continues to be made with the order for a 6000-ton forging press which Davy Brothers are supplying to the Stalingrad works of the Russian Government. The English Steel Corporation, Ltd., has manufactured all the castings at their Grimesthorpe works, Sheffield, and the latest addition to them—an anvil plate weighing 47 tons—was despatched last week.

Other Departments.

The demand for stainless, heat-resisting, and corrosion-resisting steels is fairly well maintained, and production is on a large scale. The automobile makers are taking good quantities of Sheffield products, consisting of pressings and steampings, together with special steel for wearing parts, but their requirements are still below the level of a couple of years ago. The makers of stove grates and fire-places have a fair amount of work on hand. While they have lost business through the suspension of public works schemes, schools, and so on, owing to the economy campaign, they have obtained a good deal in connection with housing schemes. Makers of heating apparatus have booked substantial work during the period of depression, though not as much as last year. In the tool and other finished sections, individual cases of improvement are to be found, but expectations of benefit from the new exchange position have not been fully realised. Imports of tools from America and the Continent have almost ceased, but large stocks have been rushed into this country—in some cases sufficient to last six or nine months—and they will have to be disposed of before any considerable advantage is gained from the anti-dumping duties.

New Steel and New Trades.

Mr. J. F. Kayser, chief metallurgist of Darwins, Ltd., Sheffield, announces that, as a result of investigation in that firm's research laboratories, a nickel-free chromium alloy steel has been evolved which can be used in furnace atmospheres containing high percentages of sulphur, and which is completely free from oxidation at 1100 deg. Cent. He points out that the completion of the research work has come at a very opportune time, and, besides the technical advantages that the new metal offers, there is the very pronounced economical advantage of being able to dispense with nickel, a metal whose cost has recently increased some 25 per cent., and the use of which materially increases the cost of any alloy to which it is added. Further interesting information about Sheffield progress is contained in a speech by Sir Halford J. Mackinder, the chairman of Sheffield Steel Products, Ltd. He states that in the last two or three years the company has brought to Sheffield from Denmark the manufacture of automatic vending machines, from Holland the making of slicing machines, from Belgium the making of certain types of weighing machines, and from the United States the manufacture of vacuum cleaners; and at the same time they had brought from the United States to Birmingham the making of a new type of wheel in connection with the use of giant pneumatic tires on heavy capacity motor vehicles.

Order for The Stanton Company.

The Stanton Ironworks Company has been successful, in the face of severe competition from foreign firms, in securing an order for the delivery of cast iron pipes, valued at approximately £3800, to the municipal gasworks in Copenhagen.

A Refractory Extension.

The sand and fire-clay works at West Calder, belonging to Messrs. J. and T. Thornton, of Hermand, West Calder, have been acquired by General Refractories, Ltd., of Sheffield. The works, which have been established many years, have large deposits of sand of very high quality for glass-making and other purposes; and a combination of the sand and fire-clay is also prepared by them, and is used in the making of iron castings.

Yorkshire and Aviation.

If Dr. Eckener, the Commander of the "Graf Zeppelin," succeeds in a scheme which he has on hand at present, there is a prospect of Howden, in East Yorkshire, where one of the great British airships was built, becoming a centre of aerial activity again. Dr. Eckener was in this country last week, and among other places which he visited were Sheffield and Howden. He states that, if the permission of the British Government can be obtained, it is proposed to start a Transatlantic air service, using Howden and Cardington as bases on this side. It is also hoped to build the airships at Howden and Cardington. The vessels will be designed largely on the lines of the "Graf Zeppelin," and will accommodate cargo and a number of passengers. It may mean considerable alterations at the two air stations, but that is a matter which will have to be studied by the architects. He has already seen the Air Minister and the Foreign Secretary in connection with the project. Colonel the Master of Sempill, who is interested in the scheme, states that if it goes through the service will be run by an Anglo-American company, in conjunction with the Zeppelin Company, of Friedrichshafen.

Cutlery and Plate.

These trades have now practically returned to the normal, the season demand having come to an end, save for oddment orders, and conditions in the main are quiet. There are some good special contracts on hand, but the general demand leaves a great deal to be desired. The scissors branch is very busy, and the trade in safety razor blades is also very strong. The firm of George H. Lawrence, Ltd., makers of the "Laurel" safety blades, has been unable to cope with the increasing flow of orders for some months, and has just acquired premises for the purpose of an additional factory. Imports of cutlery in November showed a large increase, the value being £148,878, as compared with £97,665 in October, and £22,710 in November, 1930.

NORTH OF ENGLAND.

(From our own Correspondent.)

Iron and Steel Trade Reconstruction.

RUMOURS of further unification of iron and steel concerns in the North of England are still very prevalent, but definite information of the progress in this direction is difficult to obtain. It is apparent, however, that negotiations are taking place, and the statement made by Mr. Charles Mitchell, chairman of Dorman, Long and Co., Ltd., at the annual meeting of shareholders this week, was significant, for he stressed the needs of amalgamation on a much larger scale. "The North-East Coast, in common with the rest of the British iron and steel industry," he said, "is faced with the necessity of far-reaching reconstruction of its plant and equipment. This reconstruction will have to be undertaken if the steel industry is to be preserved to this country. To be effective it will involve specialisation of output, and a higher degree of concentration than has yet been realised in this country. The capital expenditure will be heavy, and there must be therefore no misdirection of effort or unnecessary duplication of outlay. Inevitably, there must be co-operation among the several steel-producing firms. The problem is common to all of them, and only by well-considered plans of amalgamation is it practicable to carry out this reconstruction and the financial and commercial reorganisation which must accompany it. It is, I think, important to realise that amalgamation by itself is of little value. It must be applied under proper conditions and towards a clearly understood end. In this area we have physical and geographical conditions which no other iron and steel-producing district possesses. To take full advantage of these conditions, to reconstruct our plants most economically upon modern lines, to utilise fully our command of mineral resources, and to reduce our cost of production to a minimum, complete unity of interest and unity of control are essential, and to this end we are working."

Cleveland Iron Trade.

The Cleveland pig iron market is still languid. In view of the approach of the holidays, immediate needs are small, and there will be some suspension of deliveries, and a possible increase in stocks at makers' works. An unwelcome feature is the failure of customers to take up full deliveries as they fall due against running contracts. Financial difficulties and high tariffs are proving serious obstacles to an improved export trade, and shipments this month have declined. There is, however, more inquiry for January delivery, but business matures slowly. No change has been made in the fixed minimum prices and none is anticipated. No. 1 Cleveland foundry iron is 61s., No. 3 G.M.B. 58s. 6d., No. 4 foundry 57s. 6d., and No. 4 forge 57s.

Hematite Pig Iron.

Steady deliveries of East Coast hematite pig iron are being made against contracts, but new business is confined to small parcels, and no transactions of any magnitude are reported. The tone of the market, however, is still cheerful, and whilst prompt parcels of East Coast mixed numbers may be bought at 65s., rather higher prices are quoted forward.

Ironmaking Materials.

Conditions do not admit of new business in the foreign ore trade, and reliable quotations are not obtainable. Consumers are quite well placed, and they have substantial stocks and are in no hurry to take up supplies in fulfilment of old contracts made at high prices. Blast-furnace coke is slow of demand, and prices show an easy tendency. Good medium kinds are offered at 16s. 6d. to 16s. 9d. c.i.f. Tees.

Manufactured Iron and Steel.

Finished iron and steel requirements have been completed to the end of the year, and as there is no special inquiry about the arrangement of supplies for the first quarter of next year, business has been reduced to a minimum. Chiefly under old contracts, semi-steel is still arriving in this district from the Continent, but it is comparatively small in quantity, and the foreign producer, as in other sections of the industry, has lost considerable ground through the rates of exchange. In all the finished steel sections orders are urgently needed, the outstanding exception being the branches engaged in the production of constructional material, in which sections firms have substantial contracts to execute. Quotations all round are unchanged.

Welcome Ship Order.

The Furness Shipbuilding Company, Ltd., has secured an order for a new vessel of 3000 tons deadweight for its Haverton Hill shipyard on the Tees. It is of the oil tanker type, and will be built for a Canadian firm of owners. There are at present only two vessels on the stocks at Haverton Hill with an aggregate tonnage of 5000, and although this fresh order, which has been secured in face of keen competition, will not by any means place the yard in full operation, it has come as a welcome addition to the work in hand, and will tide a good many workmen over a part of the winter towards the coming of that revival in the shipbuilding trade to which everyone has been looking forward for some time.

The Coal Trade.

The Northern coal trade position for the remainder of this month and also for early January shows a brighter tendency. With the rapid approach of the holidays, shippers are showing more eagerness to secure loading turns, and are, consequently, booking stems more freely. The normal output will be curtailed by the holiday, and prices for this month and early January have, in consequence, hardened. Some of the steam coal collieries are fully sold out until the New Year, and others have little to dispose of. An interesting inquiry in the market this week is that of the Latvian State Railways, which are asking for immediate tenders for the supply of 21,000 tons of prime Northumberland and Durham steams, to be shipped to Riga, Windau and Libau during January to April. Merchants will be handicapped in tendering, as there is no ice clause in the conditions of tender. The demand for best Northumberland steam coals is as good as ever. The pits are giving large outputs, and the despatch at the staiths is well maintained. If there is a coal revival next year there will be no lack of coal production to meet it. The minimum price of 13s. 6d. for best steams has now been left behind. Direct, the price is 14s., and through second hands 13s. 6d. The Wear steam coal position is also more comfortable, with values quoted very steadily forward for prime large at 15s. Small steam coals remain a slow trade at 8s. 6d. for best qualities, and 8s. for ordinary kinds. Top grades of Durham gas coal are filling up rapidly for the remainder of the year, and clearances are likely to be brisker than they have been of late. Best gas coal is quoted at 14s. 6d. to 14s. 9d. Second qualities are also doing well at 13s. 3d. to 13s. 6d. Buyers are booking best descriptions of bunkers freely, and values are steadily hardening, best qualities being fully 14s. 3d. to 14s. 9d., but seconds remain inactive, and under good supplies offer at 13s. to 13s. 3d. There is little business in coking unscreened at 13s. to 13s. 9d., and for coking small at 12s. 6d. to 13s. 3d. Under generally improved demand all qualities of coke show a firmer tendency. Gas coke is scarce and stiffly quoted at 19s. Good quality patent oven coke is booking up freely, and quoted firm at 16s. 6d. to 17s. 6d. Superior qualities are 18s. to 21s.

SCOTLAND.

(From our own Correspondent.)

Gloomy Outlook.

THE outstanding feature during the past week has, of course, been the stoppage of work on the new Cunarder. Coming at a time when recent indications pointed to possibilities of better times on the Clyde, this interference with output is doubly disappointing, rendering, as it does, conditions still more difficult and throwing thousands of employees out of work. It is to be hoped that similar action will not be found necessary in connection with any other orders recently placed for new ships.

Featureless Markets.

Business in steel, iron and coal moving in recent times is practically without fresh feature, and markets generally are dull. Export indications are extremely moderate, and home requirements absorb very low tonnages. There may possibly be some spurt in view of the Christmas and New Year holidays, but up to the present no movement of this character is apparent.

Steel.

Steel makers as a rule are greatly in need of orders for all descriptions of material. The market is, if anything, quieter owing to the uncertainty as to the Government's action on the question of tariffs and the depreciation of sterling. Orders for plates and sections are exceedingly scarce, and outputs are curtailed to about 30 per cent. of capacity. There are indications, however, of some improvement. Steel sheets show considerable improvement, chiefly on export account. Producers mainly engaged on light gauges are particularly well placed in the meantime. Bookings in galvanised sheets are very modest, and 24-gauge is quoted from £9 10s. to £9 15s. per ton for good quantities with home prices about 15s. per ton higher. Tube makers are quiet.

Iron.

Bar iron and re-rolled steel bars are poorly specified meantime, and prices are nominally unchanged though for export bar iron might be done somewhat under £9 10s. per ton and re-rolled steel bars £6 5s. per ton. The demand for Scottish pig iron is quiet, despite the elimination of continental competition consequent on the depreciation of sterling. The number of furnaces in blast remains at five and supplies are ample.

Scrap.

The market for scrap retains a firm aspect with cast iron machinery at 57s. 6d. to 60s. per ton, and heavy steel from 40s. to 42s. 6d. per ton.

Coal.

Business in Scottish coal is affected by Polish competition, the restriction of imports with some foreign countries, the heavy tax imposed by France, and the operation of the quota system, which deprives shippers of a guarantee that they will be able to obtain fuel as required. This curtailment of output under the quota has resulted in a tightening of supplies of all fuels when shippers are due to make arrangements for shipment to the end of the year and over the holiday season. Some collieries intimated a stoppage at the middle of this month and will, therefore, be closed down now, while others have purchased from other collieries the right to produce in excess of their quotas, and have paid up to 1s. 6d. per ton for the privilege. All round fuels are becoming scarce, and though washed materials have lost business with the Continent this loss has been partly made up by increased home demands for gas and electricity purposes. Aggregate shipments amounted to 242,392 tons, against 236,033 tons in the preceding week and 120,673 tons in the same week last year.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

The Coal Trade.

FROM the figures supplied by the G.W.R. Company, returns of coal and coke shipments last week were certainly better than the preceding week, though this was rather expected, in view of the fact that the tonnage position was more satisfactory. The total shipments came to 466,935 tons, as compared with 338,915 tons, though for the corresponding period of last year the quantity was 486,714 tons. Still, last week finished up with thirty-eight vacant loading berths at the various docks in this channel, of which number, thirty-five were at Newport, Cardiff, Penarth, and Barry, where steam coals are mainly shipped. Arrivals of tonnage over the week-end meant that on Monday the number of vacant berths was reduced to sixteen, and it is quite possible that from now to the holidays there will be a further improvement in shipment operations, though it cannot be expected that this will be very appreciable, in view of the generally quiet conditions prevailing. The dullness prevailing is certainly perturbing, and causes no little amount of anxiety, not only to coalowners, but more especially shipowners, for whom current freight conditions are deplorable, both outward and homeward, with no sign of any improvement in any direction in the near future. So far as the position with France is concerned, no news has yet come to hand of any further developments on the surtax question, except that it is reported that on the French side protests continue to be made against the restrictions which are imposed by the French Government, which has issued a decree which provides that the surtax may be equivalent to the whole of the depreciation of foreign currencies. In the case of British coals, this would man that the surtax could be raised from 15 to about 32 per cent. in cases where prices in sterling have not been raised since this country went off the gold standard. As regards coal shipments to France, it is interesting to note from the Board of Trade returns that the total quantity exported from the whole of this country during November was 136,000 tons less than for the preceding month, the total of 809,413 tons being the lowest since December, 1928.

Contract Operations.

Mention has been made recently that owing to the surtax of 15 per cent. imposed by the French Government, South Wales has lost a contract for 100,000 tons of duff coals for delivery over next year. Further details of this business are not forthcoming, except that it is reported that local exporters were asked to quote some time ago for this order, but nothing more was heard of the business, which, it is presumed, has been placed elsewhere. Up to the time of writing, no news has come to hand regarding the placing of the order for the supplies of locomotive coals for the Egyptian State Railways, to which reference was made last week. These railways usually take their full time in coming to a decision, and tenders have to hold good for fifteen days from the date of their being opened. The report has been current that the Brazilian Central Railways have recently purchased a small quantity of coals, but it now turns out to be premature, and it is understood that negotiations between local firms and the railways are proceeding. The Madrid, Zaragossa and Alicante Railways of Spain have asked for tenders for about 50,000 tons of locomotive coals for delivery at Carthagena, Barcelona and Alicante over the first five months of next year. Quotations have gone in, and news is now awaited regarding the allocation of the business.

Import Trade.

The import trade of this district is slackening off, which is partly due to the fact that supplies needed for the Christmas market have practically come to an end. It is also noticeable that the imports of partly manufactured iron and steel goods are less. According to the figures for last week, these came to 23,277 tons, as against 30,843 tons for the preceding week and 18,747 tons for the corresponding period of last year. Belgium supplied fully two-thirds of the quantity which came to hand.

Railway Electrification.

According to an announcement by the Brazilian Consul at Cardiff, he has been informed by the Brazilian Government that tenders are invited for the electrification of certain portions of the Brazilian Central Railway, including different stations in Rio de Janeiro and the line to Barra do Pirai. The contract is to include the construction of a power-house.

Colliery Development.

It is reported that Messrs. Glasbrook Brothers, colliery owners of Swansea, are embarking on a development policy at their collieries at Garncoch, and part of the scheme consists of the electrification of the whole of the undertaking. It is also announced that the firm of R. S. Hayes, Ltd., of Bridgend and Maesteg, have purchased from Baldwins, Ltd., the Cribbwr Fawr Colliery, Pyle. This colliery is to be dismantled, but it is understood that the coal in that area will be worked by up-to-date electrified plant owned by Baldwins, which would necessitate the driving of new headings.

North Wales Coalfield.

The North Wales coalfield audit for October shows a credit balance of £2978, or 2·65d. per ton, compared with a loss in September of £2442 and in August of £4786. The output was 269,857 tons, yielding at an average pithead price of 12s. 10·25d. per ton, proceeds of £173,457. The costs of production were 12s. 7·60d., compared with 12s. 11·62d. in the previous month. The economic wage certified was 17·7 per cent. above the basis rates, but the minimum wage for the district is 22 per cent. above the minimum, and the payment of that involved a deficiency of £71,128, which increases the deficiency carried forward to £4,435,360.

Current Business.

The steam coal market all round continues to be very quiet, and prompt business especially is featureless. Dry coals are relatively better than other descriptions, but even for these grades the tone is not quite as strong as was the case recently. The mildness of the season is partly responsible for the reduced activity prevailing, as compared with normal winter times. In the case of smalls, the demand is still slow, and collieries in some instances are compelled to bank their surplus supplies. Coke is a firm market, but patent fuel remains quiet, while there is no improvement in the pitwood section.

LAUNCHES AND TRIAL TRIPS.

FLOATING DOCK; built by Swan, Hunter and Wigham Richardson, Ltd., to the order of the Falkland Islands Company. Dismantled in England and re-erected in the Falkland Islands.

TAGANDOEN, single-screw motor cargo vessel; built by the Netherland Shipbuilding Company, to the order of the N. V. Stoomvaart Maatschappij "Nederland"; dimensions, 490ft. 1in. by 62ft. 2¼in. by 36ft. 5in.; to carry palm oil and cargo. Oil engines, Sulzer type; constructed by Werkspoor, Amsterdam; trial trip, October 1st to 3rd.

SINGLE-SCREW Steamer; built by Swan, Hunter and Wigham Richardson, Ltd.; to carry fruit. Engines, triple-expansion, pressure 200 lb. per square inch; constructed by the builders; launch, October 26th.

MERULA, twin-screw motor tankship; built by the Netherland Shipbuilding Company; to the order of the Royal Shell Group; dimensions, 467ft. by 61ft. 9in. by 34ft.; to carry oil in bulk and general cargo. Oil engines, Werkspoor type, 2000 S.H.P.; constructed by Werkspoor, of Amsterdam; launch, November 7th.

TRENT, steam coaster; built by Richard Dunston, Ltd.; Thorne, Yorkshire; to the order of Grimsby Express Packet Company, Ltd.; dimensions, 105ft. 8in. by 20ft. by 8ft.; to carry general cargo between Grimsby and Hull. Engines, compound surface condensing, 11in. and 22in. by 16in. stroke; constructed by Plenty and Sons, Ltd., Newbury; launch, November 7th.

BEN SADLER, motor vessel; built by Rowledge Ironworks Company, Ltd., near Colchester; to the order of National Benzole Company, Ltd., London; dimensions, 132ft. by 25ft. by 9ft. 6in.; to carry bulk spirit oil. Oil engine, five-cylinder; constructed by Norris, Henty and Gardner, Ltd.; trial trip, November 10th.

FLATHOUSE, single-screw self-trimming collier; built by Swan, Hunter and Wigham Richardson, Ltd., to the order of Stephenson, Clarke and Associated Companies, Ltd., London; dimensions, 242ft. by 36ft. 6in. by 15ft.; to carry coal. Engines, triple-expansion, 19in., 31in., 51in. by 36in. stroke, pressure 180 lb. per square inch; constructed by the builders; launch, November 10th; trial trip, December 1st.

ST. ANDREW, twin-screw turbine steamer; built by Cammell Laird and Co., Ltd., to the order of the Fishguard and Rosslare Railways and Harbour Company, Ltd.; dimensions, 325ft. by 46ft. 6in. by 18ft. 9in.; to carry passengers. Engines, two sets of Parsons' turbines; pressure 230 lb. per square inch; constructed by the builders; launch, November 10th.

SINGU, single-screw steamship; built by Swan, Hunter and Wigham Richardson, Ltd., to the order of the Burmah Oil Company, Ltd.; dimensions, 380ft. by 55ft. by 29¼ft.; to carry oil in bulk. Engines, triple-expansion; constructed by Wallsend Slipway and Engineering Company, Ltd.; launch, November 10th; trial trip, December 15th.

CARBIS, twin-screw motor oil tank vessel; built by Workman Clark (1928), Ltd., to the order of Anglo-Saxon Petroleum Company, Ltd.; dimensions, 465ft. by 62ft. by 34ft.; to carry oil in bulk. Engines, oil, Werkspoor type; trial trip, December 3rd.

CONCH, twin-screw motor tanker; built by Harland and Wolff, Ltd., to the order of Anglo-Saxon Petroleum Company, Ltd. Oil engines, Harland and Wolff-B. and W. type; constructed by the builders; trial trip, December 8th.

CARDIUM, twin-screw oil tank motor ship; built by Swan, Hunter and Wigham Richardson, Ltd., to the order of Anglo-Saxon Petroleum Company, Ltd.; dimensions, 450ft. by 62ft. by 34ft.; to carry oil in bulk. Oil engines, Hawthorn-Werkspoor; constructed by R. and W. Hawthorn, Leslie and Co., Ltd.; trial trip, December 10th.

HIGHLAND PATRIOT, motor liner; built by Harland and Wolff, Ltd., to the order of the Nelson Steam Navigation Company, Ltd.; dimensions, 520ft. by 69ft. by 35ft. 9in.; to carry passengers and cargo. Oil engines, Harland-B. and W. type; constructed by the builders; launch, December 10th.

ST. DAVID, twin-screw cross channel steamer; built by Cammell Laird and Co., Ltd., to the order of the Fishguard and Rosslare Railways and Harbours Company, Ltd.; dimensions, 325ft. by 46ft. 6in. by 18ft. 9in.; to carry passengers. Engines, turbines, Parsons type, pressure 230 lb. per square inch; constructed by the builders; launch, December 10th.

TRENT, steam coaster; built by Richard Dunston, Ltd. Thorne, near Doncaster, to the order of Grimsby Express Packet Company, Ltd.; dimensions, 105ft. by 20ft. by 8ft.; to carry cargo between Grimsby and Hull. Engines, compound surface condensing, 11in. and 22in. by 16in. stroke; constructed by Plenty and Son, Ltd., Newbury; trial trip, December 12th.

CALENDARS, DIARIES, &c.

ASSOCIATED BRITISH MACHINE TOOL MAKERS, Ltd., 17, Grosvenor-gardens, S.W. 1.—Wall calendar with monthly tear-off sheets.

ASSOCIATION OF ENGINEERING AND SHIPBUILDING DRAUGHTSMEN, 98, St. George's-square, S.W. 1.—Pocket diary.

ATELIERS DE CONSTRUCTION ELECTRIQUES DE CHARLEROI, Charleroi, Belgium.—Pocket diary.

BRITISH INSULATED CABLES, Ltd., Prescot, Lancs.—Wall calendar with monthly tear-off sheets.

D.P. BATTERY COMPANY, Ltd., Bakewell, Derbyshire.—Wall calendar with monthly tear-off sheets.

DEMAG-AKTIENGESELLSCHAFT, Duisburg.—Refill for desk diary.

IRONITE COMPANY, Ltd., 11, Old Queen-street, S.W. 1.—Wall calendar with monthly tear-off sheets.

LOCOMOTIVE PUBLISHING COMPANY, Ltd., Amen-corner, E.C. 4.—Calendar with monthly tear-off slips.

NATIONAL UNION OF COMMERCIAL TRAVELLERS, 24, Thavies-inn, Holborn-circus, E.C. 1.—Pocket diary.

STAVELEY COAL AND IRON COMPANY, Ltd., near Chesterfield.—Pocket diary.

WAILES DOVE BITUMASTIC, Ltd., Newcastle-upon-Tyne.—Pocket diary.

EDWARD WOOD AND CO., Ltd., Manchester, and 68, Victoria-street, S.W.—Pocket diary.

CATALOGUES.

HATHORN, DAVEY AND CO., Ltd., Leeds.—The company's 1931 catalogue of pumping and hydraulic machinery, which also gives some useful data and tables.

ENGLISH STEEL CORPORATION, Ltd., Vickers Works, Sheffield.—A brochure illustrating and describing in detail the manufacture of forged drums for high-pressure boilers.

STANTON IRONWORKS COMPANY, Ltd., near Nottingham.—"A Few Facts About Concrete Pipes," a booklet giving some particulars about concrete pipes and their testing.

HANDY HACKSAW.—We have received for inspection from Fry's (London), Ltd., King-street, E. 1, a sample of a handy hacksaw and handle. The handle is of channel-section steel, and to it is hinged a blade some 4in. or 5in. long, which is held in the open position by a screw, but can be folded back into the handle. The tool is meant to meet conditions in which the ordinary hacksaw cannot operate and should prove useful also for the jobbing engineer's kit.

THE PHYSICAL AND OPTICAL SOCIETIES' EXHIBITION.—The twenty-second annual Exhibition of scientific instruments and apparatus, arranged by the Physical and Optical Societies, will be held on January 5th, 6th, and 7th, 1932, at the Imperial College of Science and Technology, Imperial Institute-road, South Kensington, S.W. 7. It will be open in the afternoons from 3 to 6 p.m., and again in the evenings from 7 to 10 p.m. Discourses will be delivered each day at 8 p.m. as follows:—January 5th, Mr. C. C. Paterson, O.B.E., F. Inst. P., M.I.E.E., "Photo-cells: The Valves which Operate by Light," illustrated by experiments; January 6th, Mr. T. Smith, M.A., F. Inst. P., "Photographic Shutters and their Properties," illustrated by experiments; January 7th, Sir Oliver J. Lodge, D.Sc., LL.D., F.R.S., F. Inst. P., "Reminiscences."

Current Prices for Metals and Fuels.

IRON ORE.

N.W. COAST—	
(1) Native	16/- to 20/6
(1) Spanish	17/- to 19/-
N.E. COAST—	
Native	18/- to 21/-
Foreign (c.i.f.)	16/6 to 17/-

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) SCOTLAND—		
Hematite	3 8 6	—
No. 1 Foundry	3 12 0	—
No. 3 Foundry	3 9 6	—
N.E. COAST—		
Hematite Mixed Nos.	3 5 6 to 3 6 0	
	3 5 6 to 3 6 0	
No. 1	3 6 0 to 3 6 6	
	3 6 0 to 3 6 6	
Cleveland—		
No. 1	3 1 0	3 1 0
Siliceous Iron	3 1 0	3 1 0
No. 3 G.M.B.	2 18 6	2 18 6
No. 4 Foundry	2 17 6	2 17 6
No. 4 Forge	2 17 0	2 17 0
Mottled	2 16 6	2 16 6
White	2 16 6	2 16 6
MIDLANDS—		
(e) Staffs.—	(*Delivered to Station*).	
All-mine (Cold Blast)	—	—
North Staffs. Forge	3 1 0	—
,, ,, Foundry	3 6 0	—
(e) Northampton—		
Foundry No. 3	3 2 6	—
Forge	2 17 6	—
(e) Derbyshire—		
No. 3 Foundry	3 6 0	—
Forge	3 1 0	—
(3) Lincolnshire—		
No. 3 Foundry	—	—
No. 4 Forge	—	—
Basic	—	—
(4) N.W. COAST—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	3 15 6 (a)	—
	4 0 6 (b)	—
	4 5 6 (c)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
SCOTLAND—		
Crown Bars	10 5 0	9 10 0
Best	—	—
N.E. COAST—		
Iron Rivets	11 5 0	—
Common Bars	10 10 0	—
Best Bars	11 0 0	—
Double Best Bars	11 10 0	—
Treble Best Bars	12 0 0	—
LANCS.—		
Crown Bars	9 15 0	—
Second Quality Bars	8 5 0	—
Hoops	12 0 0	—
S. YORKS.—		
Crown Bars	9 15 0	—
Best Bars	10 15 0	—
Hoops	12 0 0	—
MIDLANDS—		
Crown Bars	9 5 0 to 10 7 6	—
Marked Bars (Staffs.)	12 0 0	—
Nut and Bolt Bars	8 7 6	—
Gas Tube Strip	10 10 0 to 10 12 6	—

STEEL. (*d*)

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) SCOTLAND—		
Boiler Plates (Marine)	9 0 0	8 10 0
,, ,, (Land)	—	—
Ship Plates, ½in. and up	8 15 0	7 15 0
Sections	8 7 6	7 7 6
Steel Sheets, ¼in.	7 10 0	7 10 0
Sheets (Gal. Cor. 24 B.G.)	10 12 6	9 10 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Ship Plates	8 15 0	7 15 0
Angles	8 7 6	7 7 6
Boiler Plates (Marine)	10 10 0	—
,, ,, (Land)	10 0 0	—
Joists	8 15 0	7 7 6
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	
Channels	10 5 0	£9 to £9 5s.
Hard Billets	8 2 6	—
Soft Billets	6 17 6	—
N.W. COAST—		
BARROW—		
Heavy Rails	8 5 0	—
Light Rails	8 10 0 to 8 15 0	—
Billets	6 10 0 to 9 0 0	—
MANCHESTER—		
Bars (Round)	9 7 6	—
,, (Small Round)	7 0 0	—
Hoops (Baling)	10 0 0	9 15 0
,, (Soft Steel)	9 0 0	8 15 0
Plates	8 17 6 to 9 2 6	—
,, (Lancs. Boiler)	8 15 0	—
SHEFFIELD—		
Siemens Acid Billets	9 2 6 (basis)	—
Hard Basic	8 2 6 and 8 12 6	—
Intermediate Basic	6 12 6 and 7 2 6	—
Soft Basic	6 0 0	—
Hoops	9 10 0 to 9 15 0	—
Soft Wire Rods	7 10 0	—
MIDLANDS—		
Small Rolled Bars (all British)	7 15 0 to 8 0 0	—
Small Re-rolled Bars	6 17 6 to 7 0 0	—
Billets and Sheet Bars	5 7 6 to 5 10 0	—
Galv. Sheets, f.o.b. L'pool	9 5 0	—
(2) Staffordshire Hoops	9 10 0	—
(d) Angles	8 7 6	—
(d) Joists	8 15 0	—
(d) Tees	9 7 6	—
(d) Bridge and Tank Plates	8 17 6	—
Boiler Plates	8 12 6	—

NON-FERROUS METALS.

SWANSEA—	
Tin-plates, I.C., 20 by 14 f.o.b.	14/- to 14/6
Block Tin (cash)	136 7 6
,, (three months)	139 7 6
Copper (cash)	36 13 9
,, (three months)	37 6 3
Spanish Lead (cash)	14 16 3
,, ,, (three months)	15 1 3
Spelter (cash)	14 0 0
,, (three months)	14 10 0
MANCHESTER—	
Copper, Best Selected Ingots	40 0 0
,, Electrolytic	45 10 0
,, Strong Sheets	75 0 0
,, Tubes (Basis Price), lb.	0 0 11
Brass Tubes (Basis Price), lb.	0 0 10
,, Condenser, lb.	0 1 0½
Lead, English	16 10 0
,, Foreign	15 5 0
Spelter	14 15 0
Aluminium (per ton—raw ingot)	£95

FERRO ALLOYS.

Tungsten Metal Powder	2/4 per lb.	
Ferro Tungsten	2/- per lb.	
	Per Ton.	Per Unit.
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£25 0 0	7/-
,, ,, 6 p.c. to 8 p.c.	£24 0 0	7/-
,, ,, 8 p.c. to 10 p.c.	£22 10 0	6/6
,, ,, Specially Refined		
,, ,, Max. 2 p.c. carbon	£36 0 0	10/-
,, ,, ,, 1 p.c. carbon	£40 0 0	12/-
,, ,, ,, 0·70 p.c. carbon	£51 0 0	13/-
,, ,, ,, carbon free	11d. per lb.	
Metallic Chromium	3/1 per lb.	
Ferro Manganese (per ton)	£11 0 0 for home	
,, ,, ,,	£11 10 0 for export	
,, Silicon, 45 p.c. to 50 p.c.	£9 10 0 scale 5/- per unit	
,, ,, 75 p.c.	£16 0 0 scale 7/- per unit	
,, Vanadium	12/9 per lb.	
,, Molybdenum	6/3 per lb.	
,, Titanium (carbon free)	9d. per lb.	
Nickel (per ton)	£250 to £255	
Ferro Cobalt	8/6 per lb.	

FUELS.

SCOTLAND.

	Export.
LANARKSHIRE—	
(f.o.b. Glasgow)—Steam	13/9
,, ,, Ell	14/6
,, ,, Splint	14/3 to 15/3
,, ,, Trebles	16/-
,, ,, Doubles	13/6
,, ,, Singles	10/6
AYRSHIRE—	
(f.o.b. Ports)—Steam	13/6
,, ,, Jewel	17/-
,, ,, Trebles	16/-
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—Steam	12/6 to 13/3
Screened Navigation	17/-
Trebles	16/- to 16/6
Doubles	13/6 to 14/6
Singles	10/6
LOTHIANS—	
(f.o.b. Leith)—Best Steam	12/6 to 12/9
Secondary Steam	12/3
Trebles	16/- to 16/6
Doubles	13/6
Singles	10/6

(8) N.W. COAST— ENGLAND.

	Export.
Steams	21/-
Household	32/6 to 51/8
Coke	20/- to 21/-
NORTHUMBERLAND—	
Best Steams	13/9 to 14/-
Second Steams	12/- to 12/6
Steam Smalls	8/6 to 9/-
Unscreened	12/6 to 13/-
Household	27/- to 39/-
DURHAM—	
Best Gas	14/6 to 14/9
Second	13/6
Household	25/- to 37/-
Foundry Coke	24/-

SHEFFIELD—	Inland.	Export.
Best Hand-picked Branch	26/- to 27/-	—
South Yorkshire Best	24/- to 25/-	—
Derbyshire Best Bright House	20/6 to 21/6	—
Best House Coal	22/- to 23/-	—
Screened House Coal	19/- to 20/6	—
Best Screened Nuts	17/- to 18/-	—
Small Screened Nuts	15/6 to 16/6	—
Yorkshire Hards	17/- to 18/6	—
Derbyshire Hards	17/- to 18/6	—
Rough Slacks	9/- to 10/-	—
Nutty Slacks	8/- to 9/-	—
Smalls	5/6 to 6/6	—
Blast-furnace Coke (Inland)	11/- to 12/- on rail at ovens	
Furnace and Foundry Coke (Export), f.o.b., 17/- to 18/-		

(9) SOUTH WALES.

CARDIFF—	Export.
Steam Coals:	
Best Smokeless Large	19/6 to 19/9
Second Smokeless Large	18/9 to 19/6
Best Dry Large	19/- to 19/6
Ordinary Dry Large	17/9 to 18/3
Best Black Vein Large	18/3 to 18/6
Western Valley Large	17/9 to 18/-
Best Eastern Valley Large	17/7½ to 17/9
Ordinary Eastern Valley Large	17/3 to 17/6
Best Steam Smalls	13/- to 13/6
Ordinary Smalls	11/- to 13/-
Washed Nuts	19/- to 27/6
No. 3 Rhondda Large	19/9 to 20/-
,, ,, Smalls	15/- to 16/-
No. 2 ,, Large	17/- to 17/3
,, ,, Through	15/6 to 16/-
,, ,, Smalls	14/- to 14/3
Foundry Coke (Export)	22/- to 36/6
Furnace Coke (Export)	16/- to 17/6
Patent Fuel	19/- to 19/6
Pitwood (ex ship)	24/3 to 25/-
SWANSEA—	
Anthracite Coals:	
Best Big Vein Large	36/- to 38/6
Seconds	27/- to 31/6
Red Vein	22/6 to 27/6
Machine-made Cobbles	41/6 to 48/6
Nuts	40/- to 48/6
Beans	28/6 to 32/6
Peas	21/- to 22/-
Breaker Duff	8/6 to 9/6
Rubbly Culm	8/3 to 8/9
Steam Coals:	
Large	20/- to 20/6
Seconds	18/- to 20/-
Smalls	11/6 to 13/-
Cargo Through	16/- to 17/6

(1) Delivered. (2) Net Makers' Works. (3) f.o.b. Makers' Works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire, and Ayrshire. (6) Home Prices—All delivered Glasgow Station. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. (a) Delivered Glasgow. (b) Delivered Sheffield. (c) Delivered Birmingham. (d) Rebate: Joists (minimum), 22/6; Ordinary Ship, Bridge, and Tank Plates and Sections, 15/- if home consumers confine purchases from associated British Steel Makers. Delivered Black Country Stations.

French Engineering Notes.

(From our own Correspondent in Paris.)

Taxes on Imports.

TRADE in British engineering and other products in this country is severely affected by the depression which has overtaken France, and is deepening, and by the controversy arising out of the super-tax of 15 per cent. on the value of goods from countries with depreciated currencies and the complications that may follow upon it. The time and circumstances under which the tax was imposed suggested a measure of coercion against countries that had fallen away from the gold standard, and it was precipitate and discriminating if intended merely as a protection against depreciated currencies, which protection was quite unnecessary in view of the fact that the fall of the pound did not leave an appreciable margin of price between British and other foreign goods imported into this country, nor did it affect materially the situation of French manufacturers. The fear that the British Government contemplated retaliation, has induced the French Government to show that there is no discrimination against Great Britain by publishing a list of other countries to which the super-tax is applied, including 10 per cent. against Canada and 15 per cent. against Greece, Uruguay and some other countries that do comparatively little business with France. The fact remains that Great Britain is the only country seriously hit by the tax. There is an impression here that things have gone far enough, and that irretrievable harm has already been done to French trade with Great Britain. This impression certainly influenced the Chamber of Deputies in its rejection of the Government's proposal to increase the turnover tax on imports from 2 to 4 and 6 per cent. on the ground that it was "disguised protection." There is a strong desire to undo the disastrous effects of the coal imports restriction and the super-tax on French trade, and the failure of the partial embargo on British coal has induced the Government to fix a quota for the whole of the imports, whereby it may be increased in the case of coals that compete directly with the French collieries, and be reduced or even suppressed elsewhere. It is being made clear to the French that the super-tax against Great Britain must go if there is to be any improvement in the commercial relations between the two countries. There is no alternative other than to make some equitable arrangement with Great Britain, which the French are anxious to do, or to prepare some continental organisation on the lines of economic unions, such as it is hoped to do with Belgium, pending the carrying out of the "five years' plan" for a European Customs Union, which the French Government has submitted to Geneva. All these plans are extremely precarious. The fall of the pound and the national economy cuts in Germany affecting wages, raw material prices, railway rates, and everything else, which will reduce prices for export by something like 15 per cent., are serious matters in view of the high production costs in this country.

Industrial Groups.

Like other metallurgical concerns, the Lorraine Minière et Métallurgique has issued a warning, declaring that the iron and steel trades are heading for a catastrophe unless something is done at once to get the market out of its state of disorganisation. Since the dissolution of the Office de Statistique de Produits Métallurgiques, the prices of raw iron and steel have, it is affirmed, fallen below cost. That body was influential in controlling prices, and failed when producers threw discipline to the winds and competed for the diminishing orders that could not provide work for all. Other groups have failed in the same way, and most of those that still exist have lost all influence over the market. In present circumstances it is obvious that the only way to put a brake on the trade decline is to organise production by a restriction of output and a distribution of orders amongst members of each group, according to their productive capacity, but all similar attempts have so far failed, through the exactions of particular members of a group. An organisation of this kind is not easy in times when trade is fairly prosperous, and becomes more difficult during a period of depression. The Steel Cartel is kept alive in the hope that the decisions, come to at the Bucarest meeting a few months ago, will be carried into effect when German steel makers are able to enter again into an international combine, and meanwhile attempts are being made to revive the comptoir for centralising sales of raw steel and joists. In other branches, too, there are efforts to group international interests, which has become necessary in view of the steadily falling prices which are down to £2 14s. gold per ton for merchant bars on the Brussels Exchange and £2 15s. gold per ton for joists of English sections; while blooms are from £2 7s. 6d. to £2 8s. and billets £2 8s. 6d.

Railway Electrification.

The electrification of the Paris–Orleans Railway between Paris and Vierzon was to have been continued to Chateauroux, Limoges, and Brive, but it has been decided to postpone that extension and to carry out work on the transverse line between Les Aubrais, near Orleans, and Nantes. The first section to be electrified will be the railway from Les Aubrais to Blois and Tours. Current will be supplied from the big transformer station at Chaigny (Loiret), which is connected with Gennevilliers and the hydro-electric plants at Eguzon and the Massif Central. At Chaigny the tension is stepped down from 220,000 volts to 90,000 volts, and at Saint-Pierre-des-Corps, near Tours, it will be further transformed for traction to 1500 volts. Apart from the short sections between Culoz and Modane on the P.L.M. Railway there is no electrification, except on the Paris–Orleans and Midi railways, which run through districts supplying hydro-electric energy and have no convenient supplies of coal. For strategical reasons, there will be no electrification of the Nord and Est railways, but there is a proposal to electrify the State line between Paris and Cherbourg, though the possibility of this being done at a comparatively early date appears remote.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

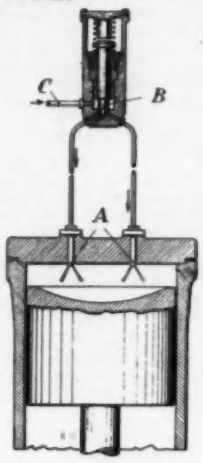
The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

INTERNAL COMBUSTION ENGINES.

359,854. March 6th, 1931.—SOLID INJECTION ENGINES, Sulzer Frères Société Anonyme, Winterthur, Switzerland.

Two or more separate fuel supply pipes for the injection nozzles lead from the seating of a common valve controlling the fuel distribution. Thus when the fuel valve is on its seating, the fuel supply pipes are not in communication with each other, and oscillation of the fuel columns in the pipes is prevented, so that uniform distribution of the fuel to the various injection nozzles and therefore effective injection and combustion are ensured. The injection nozzles are shown at A, the fuel valve at B, and the oil supply pipe at C.—*October 29th*, 1931.

Nº359854

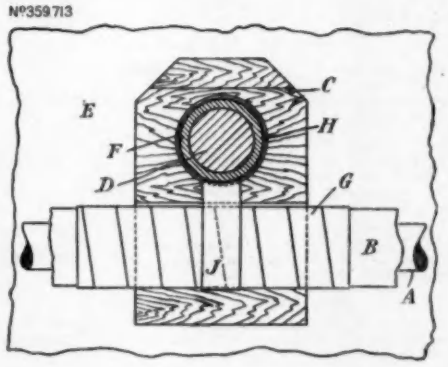


DYNAMOS AND MOTORS.

359,713. October 23rd, 1930.—HIGH-TENSION ELECTRICAL MACHINES, Siemens-Schuckertwerke Aktiengesellschaft, of Berlin-Siemensstadt, Germany.

This invention relates to high-tension electric machines, which possess "ring mains" secured by bolts. In such machines there is the risk that a glow discharge will take place at high tensions between the bolts and the main. The illustration shows part of a ring main constituted by a conductor A wrapped round with insulation B. This part is mounted in a holder C,

Nº359713

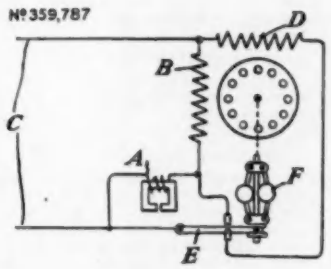


which rests on a bolt D, secured to the iron E of the machine. In the vicinity of the crossing both the main A and the bolt sleeve F are surrounded with semi-conducting coverings G and H, for which graphite paint or asbestos band may be used. Both the semi-conducting covers are connected together by a semi-conductor J, which may be made of asbestos. Under the action of the high resistance of the additional coverings the capacity currents generated produce a particularly favourable field distribution, and thus avoid the injurious glow discharge.—*October 29th*, 1931.

359,787. December 10th, 1930.—ELECTRIC MOTORS, *The British Thomson-Houston Company, Ltd., of Crown House, Aldwych, London, W.C. 2.*

The main object of this invention is to provide a reliable, inexpensive starting arrangement for single-phase induction motors, giving low starting current, while retaining the desirable features of high maximum output, good starting torque, and efficient running operation of this type of motor. This is largely accomplished by connecting a suitable inductive reactor A in series with the main running winding B at starting and connecting both primary winding circuits to the line C. Under these conditions, the phase of the current in winding B is very appreciably retarded behind that in winding D, and the desired rotating field component for starting is established. The reactor, in addition to producing the desired difference in phase in the currents in the two windings, also serves the very important function of limiting the starting current drawn by the main winding B. The starting winding D is of such a high resistance that the starting current drawn by it is not excessive. The inherent resistance of this winding also assists in producing the desired phase angle difference between the currents in the two windings at start. Thus the inventors obtain good starting torque without excessive starting current. As the motor comes up to speed, it is desirable to change these conditions in order to obtain efficient operation at normal speed of the motor, and for this purpose the inventors provide a speed responsive switch E, operated by a centrifugal device F. This switch short circuits the reactor A and opens the starting winding circuit, leaving the main winding B connected directly to the line for normal operation.—*October 29th*, 1931.

Nº359787



TRANSMISSION OF POWER.

360,693. November 25th, 1930.—ELECTRICAL, HOLLOW, STRANDED CONDUCTORS FOR ELECTRICAL HIGH-TENSION LINES, Felten und Guilleaume Carlswerk Actien-Gesellschaft, of Köln-Mülheim, Germany.

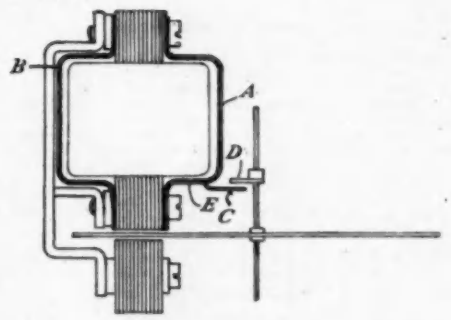
A hollow stranded H.T. overhead line conductor, having greater flexibility than that of conductors hitherto employed, is described in this specification. Hollow conductors are already known in which the part intended for carrying the current is composed of one or more layers of solid wires of good conducting material. The desired flexibility of the cable is obtained in accordance with this invention by the use of stranded conductors instead of solid wires, which are stranded directly around a metal supporting member of known construction, as, for instance, around a bronze helix, the stranded conductors being of circular or other shape.—*November 12th*, 1931.

MEASURING AND TESTING INSTRUMENTS.

360,473. August 7th, 1930.—BOBBINS FOR ELECTRICITY METERS AND ELECTRIC MEASURING INSTRUMENTS, Landis et Gyr S.A., of Hofstrasse 1, Zug, Switzerland.

For the enclosure of electricity meter bobbins the inventors use iron shields A and B, each provided with an insulating lining and secured on opposite sides of the core. At C there is a metal strip, which is magnetised by current from the mains and acts upon a pin D mounted on the motor spindle, and serves for preventing idle running of the meter. The aperture E produced by stamping out the metal strip C can be used for the reception of the conductors of the bobbin. In addition to giving mechanical protection to the bobbin the iron enclosure also serves as a screen for magnetic fields.—*November 9th*, 1931.

Nº 360,473



360,781. March 5th, 1931.—SPEED INDICATORS, B. Thormann 26, Sachs-Allee, Berlin-Dahlem, Germany.

This invention relates to a speed indicator of the kind wherein the pointer shaft is moved by frictional impulses against the influence of the spring, and the invention consists in providing the driving shaft with a segmental disc and the driven shaft with a pair of friction discs between which the segmental disc is adapted to engage for imparting movement to the indicator. The driving shaft A of the indicator carries, in addition to a worm B for driving the usual mileage counter, a segmental disc H adapted to engage intermittently between two resilient friction discs I and K mounted on a driven shaft C. The latter is fitted with a pinion D, which meshes with the gear wheel E on a shaft F controlled by a spiral spring T. The upper end of the shaft F has a bearing in a sleeve N, which is rotatable relative to the shaft as well as to the supporting plate Q. Above the latter the sleeve N carries a pointer G and it is formed below the plate with a flange O. An arm R on the shaft F fits into a recess S in the flange O for coupling the shaft to the sleeve and to the pointer. The recess S is wider than the arm R so that limited rotary displacement of the shaft relative to the pointer can take place. The movement of the pointer is braked by a coil spring P which is connected to the pointer and which bears against the plate Q. The action is as follows:—The spring T tends to maintain the pointer in its zero position. At each revolution of the shaft A the segment H engages between the friction discs I K, and rotates the shaft C through an angle corresponding to the size of the segment. The shaft F participates in the rotation and turns through a much smaller angle in opposition to the spring T, which tends to restore both shafts to their initial positions as soon as the friction discs are released from the segment H. When the movement of the latter is very slow, the spring will have time between successive impulses to restore the

Nº360,781 Fig. 1.

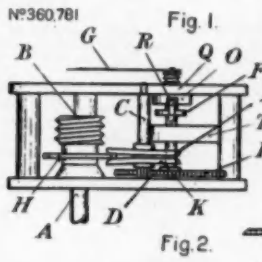


Fig. 2.

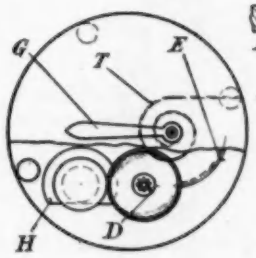
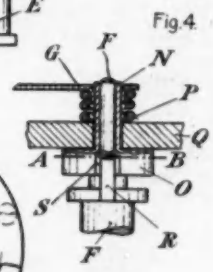


Fig. 4.

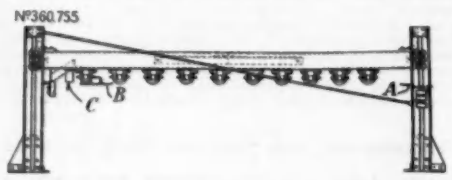


shafts to their initial positions, and the arm R will merely be oscillated from one side to the other of the recess S without effecting the pointer. At greater speed, however, the pointer will be gradually advanced until the tension of the spring T has increased enough to maintain the pointer in a given position. The actual position of the pointer is determined by the speed. Vibratory movement of the pointer is prevented by the brake spring P and by the free play of the arm R in the recess S.—*November 12th*, 1931.

MACHINE TOOLS AND SHOP APPLIANCES.

360,755. January 28th, 1931.—STACKING STEEL PLATES, J. Summers and Sons, Ltd., Hawarden Bridge Steel Works, Shotton, Flint, K. Younghusband, and W. H. Corlett.

For the purpose of conveying sheets of steel or iron from, say, a flattening machine to a trolley for stacking into a pile and dispatch, the inventors use a series of magnetised overhead rollers. The sheets are fed under these rollers, over a guide A

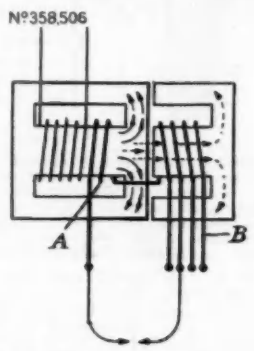


and are carried forward by their rotation. At the end of the bridge there are a skid bar B, which checks the speed of the sheet, and a switch C. The sheet on meeting the trigger of this switch opens the circuit of the electromagnets of the rollers, and the plate drops on to the pile. The switch then resumes its normal position and the rollers are ready for another sheet.—*November 12th*, 1931.

MISCELLANEOUS.

358,506. July 8th, 1930.—ALTERNATING ELECTRIC CURRENT ARC WELDING APPARATUS, John Bentley Hansell, of 121, Eccles Old-road, Pendleton, Manchester, and Associated Electrical Industries, Ltd., of Crown House, Aldwych, Westminster.

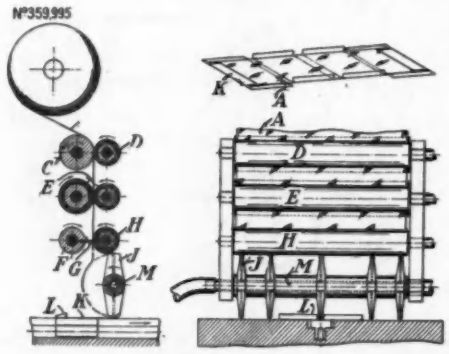
Arc-welding apparatus according to the present invention is provided with a single transformer structure for supplying power to the arc. The secondary winding is divided into



two series connected sections A and B, one section being closely wound with the primary winding on a closed transformer core, the other section B, which is provided with tappings, being wound on an auxiliary core separated from the closed core by an air gap, whereby the other section is but loosely interlinked with said primary winding. The loosely interlinked section of the secondary winding serves as a choke coil, and takes the place of the independent unit usually provided.—*October 8th*, 1931.

359,995. June 2nd, 1930.—PACKING MACHINERY, Donald Jackson and Molins Machine Company, Ltd., both of 2, Evelyn-street, Deptford, London, S.E. 8.

This invention comprises means for feeding and depositing a strip of material, for example, a strip of tin foil, on to the surface of a packet blank fed beneath the foil. The web of foil A is fed from a reel by a pair of rollers arranged to emboss a design on the foil. One of the rollers C is made of hard metal and has a design engraved thereon, and the co-operating roller D is of soft rubber. From these rollers the foil passes to a second pair of pulling rubber rollers E. The web of foil next passes through a cutting mechanism comprising a rotating roller F having a blade G and arranged to contact with a roller H of felt. The knife is provided with a saw tooth edge, the points of which, on coming



into contact with the foil, pierce it and form a line of perforations across the foil. The knife continues to rotate and owing to the shape of the teeth each tooth cuts the foil in its immediate neighbourhood with a shearing action so that the effect is equal to a single continuous shearing cut. The piece of foil, at the time of cutting, is arranged to hang downwardly from the cutting rollers, and at the instant of cutting a moving gripper, for instance, a rotating suction member J, is arranged to seize the leading end of the foil and carry it in an arcuate path as indicated by the dotted line until the leading edge is laid upon the packet blank K whereupon the suction ceases and the trailing end of the foil falls down on to the blank which is carried away by a pusher piece L of a conveyor. The suction member J rotates on a fixed pipe M through which the air passes to a pump.—*November 2nd*, 1931.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Tuesday of the week preceding the meetings. In all cases the TIME and PLACE at which the meeting is to be held should be clearly stated.

TO-DAY.

INSTITUTE OF CHEMISTRY.—30, Russell-square, London, W.C. 1. "Third S. M. Gluckstein Memorial Lecture: The Chemist and the Community," by Sir Frank E. Smith, F.R.S. 8 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS: NORTH-EASTERN STUDENTS' SECTION.—Armstrong College, Newcastle-upon-Tyne. "The Design of D.C. Machines for Moderate Outputs," by Mr. G. Waters. 7.15 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, S.W. 1. "The Development of the Talking Picture," by Mr. W. Harris. 7.30 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, Piccadilly, W. 1. Discourse, "The Education of the Average Man," by Rev. C. Alington. 9 p.m.

SATURDAY, DECEMBER 19TH.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS: TEES-SIDE BRANCH, GRADUATE SECTION.—In the Cleveland Scientific and Technical Institution, Middlesbrough. Paper by Mr. H. McIvor. 7.30 p.m.

TUESDAY, DECEMBER 22ND.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Segrave Club, Queen-street, Wolverhampton. "Transmission," by Mr. L. H. Pomeroy. 7.30 p.m.

TUESDAY, DECEMBER 29TH.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, Piccadilly, W. 1. Christmas Lecture. The Universe of Light: Lecture I., "The Nature of Light," by Sir William Bragg, F.R.S. 3 p.m.

THURSDAY, DECEMBER 31ST.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, Piccadilly, W. 1. Christmas Lecture. The Universe of Light: Lecture II., "Light and the Eye," by Sir William Bragg, F.R.S. 3 p.m.

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FRIDAY, JANUARY 1ST.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, S.W. 1. "Photogravure and the Intaglio Press," by Mr. B. A. Gooderham. 7.30 p.m.

SATURDAY, JANUARY 2ND.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, Piccadilly, W. 1. Christmas Lecture, "The Universe of Light"; Lecture III., "Light and Colour, I.," by Sir William Bragg, F.R.S. 3 p.m.

MONDAY, JANUARY 4TH.

WOLVERHAMPTON AND DISTRICT ENGINEERING SOCIETY.—The Victoria Hotel, Wolverhampton. "The Mechanical Principles Embodied in Weighing Machines," by Mr. W. A. Benton. 7.30 p.m.

TUESDAY, JANUARY 5TH.

INSTITUTION OF AUTOMOBILE ENGINEERS.—At the House of the Royal Society of Arts, John-street, Adelphi, W.C. 2. "Oil Consumption in Relation to Cylinder and Piston Wear," by Mr. E. C. Ottaway. 7.45 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, Piccadilly, W. 1. Christmas Lecture, "The Universe of Light, Lecture IV., Light and Colour, II.," by Sir William Bragg, F.R.S. 3 p.m.

WEDNESDAY, JANUARY 6TH.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Queen's Hotel, Birmingham. "The Training of Young Automobile Engineers," by Mr. B. G. Robbins. 7.30 p.m.

THURSDAY, JANUARY 7TH.

INSTITUTION OF CIVIL ENGINEERS: BIRMINGHAM AND DISTRICT ASSOCIATION.—In the Chamber of Commerce, Birmingham. "The Underpinning of a Heavy River Wall," by Mr. Wm. Muirhead. 6 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, Piccadilly, W. 1. Christmas Lecture, "The Universe of Light, Lecture V., Light from the Sky," by Sir William Bragg, F.R.S. 3 p.m.

FRIDAY, JANUARY 8TH.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's Gate, St. James's Park, London, S.W. 1. Thomas Lowe Gray Lecture. "Modern Types of Propelling Machinery for Mercantile Marine Use," by Mr. Sterry B. Freeman. 6 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, S.W. 1. "Refrigeration: Modern Practice and Practical Calculations," by Mr. B. C. Oldham. 7.30 p.m.

SATURDAY, JANUARY 9TH.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, Piccadilly, W. 1. Christmas Lecture, "The Universe of Light, Lecture VI., Light from the Sun and the Stars," by Sir William Bragg, F.R.S. 3 p.m.

MONDAY, JANUARY 11TH.

INSTITUTE OF METALS: SCOTTISH LOCAL SECTION.—In the Rooms of the Institution of Engineers and Shipbuilders in Scotland, 39, Elmbank-crescent, Glasgow. "Some Properties of Fire-bricks," by Mr. H. C. Biggs. 7.30 p.m.

TUESDAY, JANUARY 12TH.

INSTITUTE OF METALS: BIRMINGHAM LOCAL SECTION.—In the Chamber of Commerce, New-street, Birmingham. "Stainless Steel," by Mr. J. H. G. Monypenny. 7 p.m.

INSTITUTE OF METALS: NORTH-EAST COAST LOCAL SECTION.—In the Electrical Engineering Lecture Theatre, Armstrong College, Newcastle-on-Tyne. Discussion on "Defects in Non-ferrous Castings," by Messrs. R. Dowson, S. G. Homfray and A. Logan. 7.30 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Graduates' Meeting, Watergate House, Adelphi, W.C. 2. "Carburation," by Mr. E. W. Knott. 7.25 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS.—Hotel Metropole, Leeds. "Two Transmission Line Problems," by Mr. P. J. Ryle. 7 p.m.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND.—39, Elmbank-crescent, Glasgow. "Modern Methods of Steel Bridge Manufacture," by Mr. J. Thomson. 7.30 p.m.

THURSDAY, JANUARY 14TH.

INSTITUTE OF METALS: LONDON LOCAL SECTION.—In the Rooms of the Society of Motor Manufacturers and Traders, Ltd., 83, Pall Mall, S.W. 1. "X-Ray Examination of Alloys," by Mr. G. D. Preston. 7.30 p.m.

INSTITUTION OF CIVIL ENGINEERS: BIRMINGHAM AND DISTRICT ASSOCIATION.—In the Chamber of Commerce, Birmingham. Vernon Harcourt Lecture, "The Mechanical Handling of Coal at Ports," by Mr. N. G. Gedye, 6 p.m.

INSTITUTION OF MECHANICAL ENGINEERS: YORKSHIRE BRANCH. Hotel Metropole, Leeds. Annual General Meeting. "Recent Developments in the Treatment of Boiler Water," by Dr. A. W. Chapman. 7.30 p.m.

FRIDAY, JANUARY 15TH.

INSTITUTE OF METALS: SHEFFIELD LOCAL SECTION.—In the Non-ferrous Section of the Applied Science Department of the University, St. George's-square, Sheffield. "Stresses in Metals," by Mr. A. Wragg. 7.30 p.m.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's Gate, St. James's Park, S.W. 1. Informal Meeting. Discussion on "Industrial Conditions in Russia," introduced by Mr. J. Fearn. 7 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, S.W. 1. "The Development of the Loud Speaker," by Mr. H. J. N. Riddle. 7.30 p.m.

THURSDAY, JANUARY 21ST.

INSTITUTE OF METALS: BIRMINGHAM LOCAL SECTION.—In the Chamber of Commerce, New-street, Birmingham. "Electric Welding of Non-ferrous Alloys," by Dr. A. Burstall. 7 p.m.

INSTITUTION OF STRUCTURAL ENGINEERS.—Hotel Metropole, Leeds. "The Employment of Structural Engineers as Specialists," by Mr. W. T. Cresswell. 7 p.m.

FRIDAY, JANUARY 22ND.

INSTITUTION OF LOCOMOTIVE ENGINEERS.—Hotel Metropole, Leeds. "Progressive Methods Applied to a Modern Shop for Electric Rolling Stock," by Colonel E. Graham. 7.15 p.m.

WEDNESDAY, JANUARY 27TH.

BRITISH WOOD PRESERVING ASSOCIATION.—In the Lecture Hall, Auctioneers' and Estate Agents' Institute, 29, Lincoln's Inn-fields, London, W.C. 2. "Diseases of Timber," by Mr. K. St. G. Cartwright. 6 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Engineers' Club, Manchester. "Transmission," by Mr. L. H. Pomeroy. 7 p.m.

MONDAY, FEBRUARY 1ST.

WOLVERHAMPTON AND DISTRICT ENGINEERING SOCIETY.—The Victoria Hotel, Wolverhampton. "Waste Heat Boilers," by Mr. F. Jones. 7.30 p.m.

MONDAY, FEBRUARY 15TH.

WOLVERHAMPTON AND DISTRICT ENGINEERING SOCIETY.—The Victoria Hotel, Wolverhampton. "Beet Sugar Manufacture," by Dipl. Ing. Karl Hampel. 7.30 p.m.

MONDAY, MARCH 7TH.

WOLVERHAMPTON AND DISTRICT ENGINEERING SOCIETY.—The Victoria Hotel, Wolverhampton. "Steam Generation in Factories," by Mr. H. E. Partridge. 7.30 p.m.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

MR. PHILIPS-SMITH has allied himself with the Wayne Tank and Pump Company, Ltd., as consultant and adviser on petrol-metering installations.

BUCK AND HICKMAN, Ltd., of Whitechapel-road, London, E. 1, ask us to announce that their Birmingham office, until recently in charge of Mr. Gordon Dowding, has now been handed over to Mr. J. E. MacLaren.

WESTON ELECTRICAL INSTRUMENT COMPANY, Ltd., asks us to announce that its new offices and works on the Kingston By-pass, London, are now completed, and asks that in future all correspondence should be addressed to it at Kingston By-pass, Surbiton, Surrey (telephones, Elmbridge 6400 and 6401; telegrams, Pivoted, Surbiton).

BRITISH ISOTHERMOS COMPANY, Ltd., asks us to announce that as from December 24th, 1931, its London address will be changed from Park House, 22–26, Great Smith-street, to Thames House, Westminster, London, S.W. 1. Telephone numbers: Victoria 2233 and 1294. Telegrams: Isothermos, Churton, London. Cables: Isothermos, London.

MR. THEODORE PEART, of Rochester Chambers, 26, Collingwood-street, Newcastle-on-Tyne, informs us that he has been appointed to represent Adams-Hydraulics, Ltd., of York, in the counties of Northumberland, Durham, Yorkshire, Cumberland, Westmoreland, Lancashire, and Cheshire, for the sale of the firm's patented air sewage ejector plant and Amphistoma sewage pumping plant for marine work.

CONTRACTS.

SIR WILLIAM ARROL AND CO., Ltd., have received an order for a 25-ton electric wharf crane from Barclay, Curle and Co., Ltd., Elderslie Dockyard, Scotstoun.

RICHARD DUNSTON, Ltd., Thorne, near Doncaster, has received an order for a steel lighter, capable of carrying over 1000 quarters of grain. The vessel will have five separate holds in order that five different classes of grain can be carried in case of need.

THE L.M.S. RAILWAY COMPANY announces the placing of the following contracts:—(*a*) With a Nottingham firm for a new goods warehouse at Nottingham; (*b*) with a Wellington firm for girderwork, November, 1931; (*c*) with a Blackpool firm for new electric sub-stations at Southport and Wicky Dale; and (*d*) with a Glasgow firm for a footbridge at Burnside Station, Scotland.

BEYER, PEACOCK and Co., Ltd., have received from the Great Northern of Ireland Railway an order for five three-cylinder, compound, express passenger locomotives, having a 4–4–0 wheel arrangement. The same firm has also received a repeat order from the Peruvian Corporation for one "Beyer-Garratt" locomotive for the Central Railway of Peru; from the Sneyd Collieries, Ltd., Staffordshire, for a type "Beyer-Garratt" locomotive for operation on 1 in 18 gradients and curves of 90ft. radius; and from La Société Franco-Belge de Material de Chemins de Fer, on behalf of the Algerian Section of the P.L.M. Railway, an order for a self-trimming bunker, to be fitted to an express "Beyer-Garratt" passenger locomotive now under construction at Raismes, France. The firm has also ready for shipment to Sierra Leone, two "Beyer-Garratt" locomotives of approximately 50,000 lb. tractive efforts.